

11-2010

Using GigaPan to Photograph Long Plant Specimens

Steve Renich
The Land Institute

Scott Bontz
The Land Institute

Follow this and additional works at: <http://repository.cmu.edu/gigapixel>

Published In

Proceedings of the Fine International Conference on Gigapixel Imaging for Science.

This Conference Proceeding is brought to you for free and open access by the Conferences and Events at Research Showcase @ CMU. It has been accepted for inclusion in Fine International Conference on Gigapixel Imaging for Science by an authorized administrator of Research Showcase @ CMU. For more information, please contact research-showcase@andrew.cmu.edu.

Using GigaPan to Photograph Long Plant Specimens

Steve Renich

The Land Institute

renich@landinstitute.org

Scott Bontz

The Land Institute

bontz@landinstitute.org

ABSTRACT

GigaPan combined with a dedicated concave subject table makes virtually distortion-free, life-size photos of prairie plants with roots more than 10 feet long. The pictures travel to display the mass, detail, and importance of otherwise hidden soil life structure. GigaPan helps The Land Institute enlist support for development of an agriculture modeled on nature's polyculture of perennials – Natural Systems Agriculture.

Keywords

Perennials, Roots, Food, Soil, Polyculture

INTRODUCTION

Ilah Nourbakhsh, of Carnegie Mellon University's Robotics Center, heard Land Institute President Wes Jackson speak about the institute's work, and invited our participation in the new GigaPan program. Wes offered the opportunity to me. I am the Institute's operations manager, working with scientists, support staff, tractors, computers, and commodes. Here, an interest in technology, old and new, is helpful. Earlier in life - while in high school and college - I photographed sports for a newspaper, worked in a professional darkroom, took wedding pictures, and served as a television cameraman. Later, after half a dozen years in chemistry, I took a sabbatical to work as a carpenter and builder for 25 years. Those eras come into play with GigaPan.

LEARNING

At a workshop in Colorado I was taught the basics of GigaPan in about 30 minutes. The technique involves visualizing the top left and bottom right corners of an image, then setting up the GigaPan robot to pan between the two and take pictures along the way. Executing a GigaPan array might take fewer than 15 minutes or more than two hours. With the initial post-photo software program, stitching the pictures together could take hours or even days. Current software is 10 times faster. What once took all night now can be done in minutes.

THE POWER OF ROOTS

The predominant use of the GigaPan at The Land Institute has been in making images of plants up to 16 feet long. Ten feet or more of this length is dense roots. These deep roots of perennial grasses and forbs are a natural "technical" marvel themselves, superior in many ways to the roots of annual crops, which are relatively short and short-lived. The institute's work is to develop perennial crops to replace the annuals. These crops – wheat, rice, corn, soybeans, sunflower, and a few others – provide the majority of human food

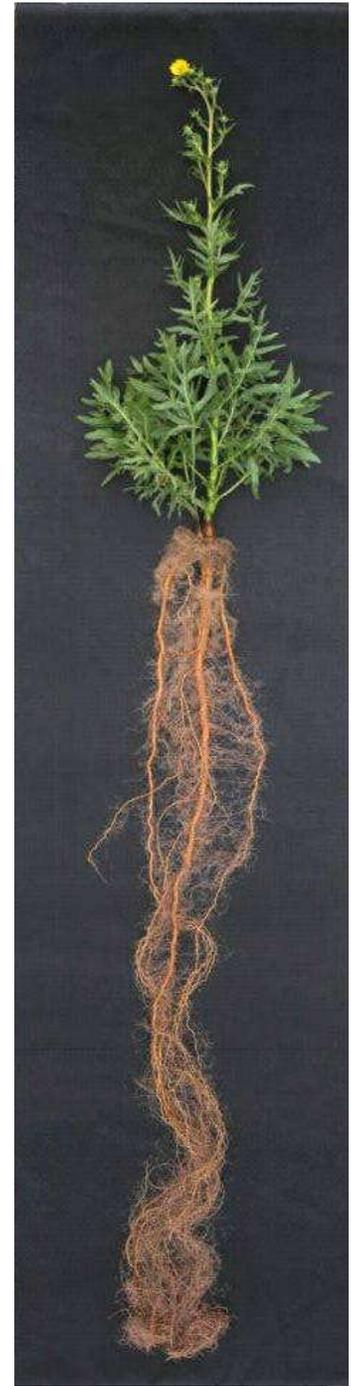


Figure 1. Compass Plant
4 ft by 16 ft

calories. They do so at great expense – energy consumption, soil erosion, water pollution, and wasted nutrients. Most natural vegetation, the kind that can retain and even build soil, is a mixture of perennials.

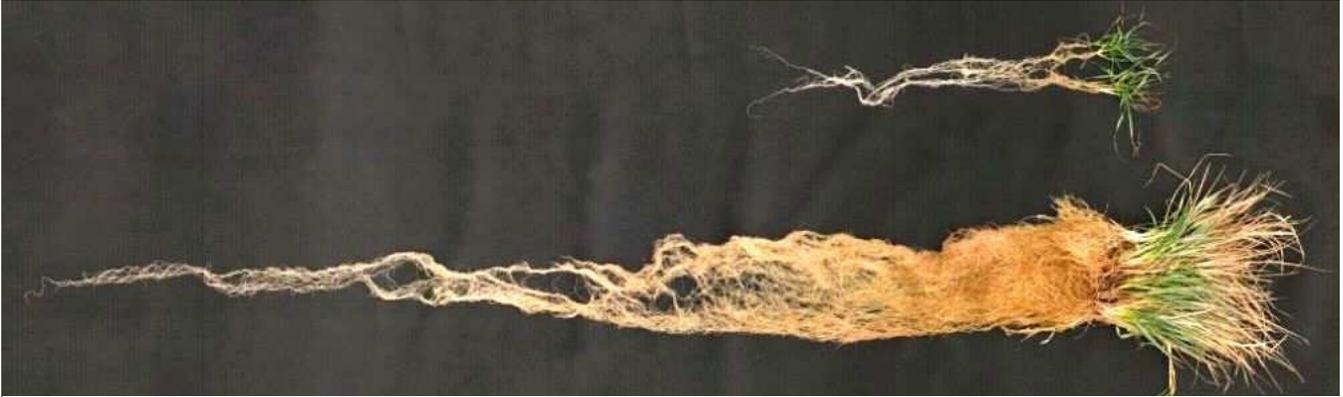


Figure 2. Annual Wheat and Perennial Wheatgrass – 3 ft by 10 ft
(See Appendix for Image GigaPan Links)

The importance of the world’s usually hidden root architecture can be easily exposed by showing people those roots. The Land Institute and a few others have done this by growing plants in long plastic tubes. We fill the tubes not with soil, but with a growth medium that can be washed away and not damage the fine fibers. Still, traveling with the roots is difficult and



Figure 3. Root Tube Array

takes a toll on them. With GigaPan, we make richly detailed, lifesize, 16-foot prints. The pictures roll out to make impressive images. Land Institute representatives have carried them around the world.

FLATTENING A CURVE

To photograph these roots I wanted to avoid the curving-away perspective that would come with GigaPan swinging over plants laid on a flat surface. I had a plan. First I marked two 4x8-foot sheets of plywood with a grid on 1-foot centers. I positioned them end-to-end centered by plumb-bob under the truss system of the greenhouse. Where the bob had hung 10 feet above the plywood I attached the robot to a mount fashioned from a Manfrotto tripod head, a piece of 4x4, a small slab of plywood, and a heavy bolt.

In a test image the flat grid converged near the ends, as expected. An image taken after raising the sheet ends with bricks proved better. From there, I built a 4x16-foot plywood cylinder segment, or 'half-pipe,' with a 10-foot radius to keep 16 feet of plant equidistant from the camera. The resulting image showed little distortion.

Making GigaPan images of roots freshly drawn from their growth tubes progressed by trial and error. I learned to turn off greenhouse circulation fans and avoid blurring vibration of the truss and camera. Also, to delay the shutter until the robot itself had steadied. I went to making pictures early in the morning, before sunlight struck the greenhouse directly enough to cast truss shadows on the ground.



Figure 4. GigaPan Subject Table

ELEVATION: NEED AND MEANS

I also learned GigaPan technique away from the root photos in the greenhouse. Living on the Plains, and with various robot mounting devices, I've had a tendency to climb ladders. Otherwise about all you're going to see in Kansas is a horizon with a telephone pole, and it may be a mile away.



Figure 5. Kernza[®] – Intermediate wheatgrass (*Thinopyrum intermedium*)

A perennial being crossed with wheat to develop a perennial wheat line, and being developed itself for human food

The tripod was mounted atop an 8 foot stepladder standing in a truck bed

A CAMERA OF FOREST AND TREES

I see two results of using GigaPan. There is the full image, and within it numerous potential images of selected parts. There's lots of information that the photographer or viewer can come back to after taking in the overall picture. While laden with detail, many of my full images aren't particularly noteworthy. Great detail is basic with GigaPan technology; creating a pleasing overall picture remains a challenge.

DEMANDS OF THE MEDIUM

A difference between using a standard camera and GigaPan is the care required arranging the latter. It's like using a view camera, on a tripod, image upside down on ground glass viewed under a dark cloth; the image however, is not even on ground glass – it is, until stitched, only in the mind's eye. You don't approach a picture casually.

One of my most challenging pictures away from the roots experience was a 360-degree sweep from the summit of Mount Evans in Colorado. I set up by a steep drop in high wind that kept me holding the tripod steady. I repeatedly paused and restarted the robot to avoid incorporating in the picture the "motion artifacts" of other visitors. The interruptions almost made me give up. But toward the end of an hour and a half of exposures came a lull and the site emptied. I retook the last half of the GigaPan array. Back home, I spent a couple of hours manipulating on the computer to sub in the better versions of individual pictures.



Figure 6. Mount Evans – 360°

THE PERSPECTIVE UNDERGROUND

Back to roots: early on they became the driving application for GigaPan at The Land Institute. I was inspired by the man behind the roots project, Land Institute soil scientist Jerry Glover. Glover hopes that, with hundreds of roots accumulated and preserved, he will work with a museum to arrange a subterranean forest through which visitors can walk and soak up a three-dimensional impression of the importance of something unseeable in the field.

There are occasional exceptions to that hidden real-life view. Glover has arranged for a backhoe to dig 8-foot-deep pits with a vertical face showing annual and perennial roots exposed side-by-side. This scene is the most viewed among my images on the GigaPan web site. The backhoe bucket cut a vertical plane, so here GigaPan's sweeping perspective turns straight lines into arcs. I think our skilled backhoe operator could, if given additional time and space, carve a wall like my curved table, so the distance of subject to camera remains constant and the resulting image appears flat.

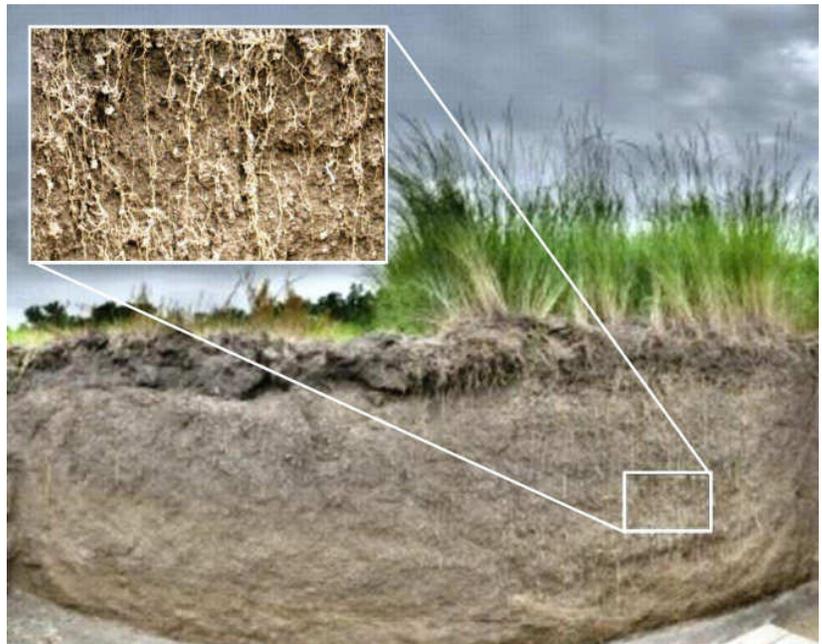


Figure 7. Wheat / Wheatgrass Root Pit

CATCHING A SEA OF GRASS

What I have not yet shown well with GigaPan's rich detailing is The Land Institute's field plots of perennial grains in the making, a picture made difficult by Kansas winds.



Figure 8. Overlooking Research Plots

REVEALING AND FRAMING THE WORLD

So GigaPan has helped impress perhaps thousands of people with something they otherwise would not have seen, and raised their awareness of its importance. Working at The Land Institute, I already knew that story. But GigaPan has also changed my awareness. Now I tend to look at the world with a top left and lower right in mind.

APPENDIX

The Land Institute
2440 E Water Well Rd
Salina, KS 67401
785-823-5376
<http://www.landinstitute.org/>

Figure 1. Compass Plant ~ 4 ft by 16 ft

<http://www.gigapan.org/gigapans/28286/>

Figure 2. Annual Wheat ~ Perennial Wheatgrass ~ 3 ft by 10 ft

<http://gigapan.org/gigapans/41194/>

Figure 3. Root Tube Array

<http://www.gigapan.org/gigapans/7174/>

<http://www.gigapan.org/gigapans/22036/>

Figure 4. GigaPan Subject Table

<http://www.gigapan.org/viewGigapan.php?id=8037>

see also: (<http://www.gigapan.org/gigapans/7083/>)

(<http://www.gigapan.org/gigapans/7257/>)

Figure 5. Intermediate wheatgrass (*Thinopyrum intermedium*)

<http://www.gigapan.org/gigapans/52633/>

Figure 6. Mount Evans ~ 360⁰

<http://gigapan.org/gigapans/7800/>

Figure 7. Wheat / Wheatgrass Root Pit

<http://gigapan.org/gigapans/6676/>

Snapshot. <http://gigapan.org/gigapans/6676/snapshots/171339/>

Figure 8. Overlooking Research Plots

<http://gigapan.org/gigapans/7452/>