Tracking Pests and Plant Diseases Using Geo-tagged Digital Images

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The ability to track the locations of pests and plant diseases is important for pest management. With advances in digital imaging technology, one distinct feature of the current digital cameras is that images could provide not only pictures of objects you have taken, but also metadata called Exchangeable Image File Format (EXIF) embedded in the image. Two important data embedded in the geo-tagged photos are GPS coordinates and timestamp. Such geo-tagged images provide us with information of *what, when and where*. Thus images with GPS coordinates can be seamlessly transferred to a computerized mapping system to assist pest tracking and management. The Distance Diagnostic and Identification System (DDIS) now accepts geo-tagged images and provides a module for pest mapping. By using the geo-tagged images, it allows us to track or map pest locations through time and space.

Producing Geo-tagged Images

Almost every new digital camera supports the EXIF metadata embedded in the digital image. Table 1 lists a few samples of GPS enabled cameras and devices for digital cameras. Users may produce geo-tagged images by one of these means:

1) Use a camera with built-in GPS such as Ricoh's 500SE. GPS coordinates are directly written to the EXIF metadata for cameras with built-in GPS or cameras to directly connect to an external GPS device, such as Nikon D90 or Nikon D300.
2) Use an external GPS device for a camera without built-in GPS such as *PhotoTrackr*. This approach doesn't write GPS coordinates directly into the image EXIF metadata when a photo is taken. Instead, the software provided by the product is used to synchronize GPS coordinates with the photos on your computer.
3) Software is available to modify the EXIF metadata. You may add geo-tags to an image if you know the GPS coordinates, which could be obtained by a GPS device or the map provided by the software vendors. The DDIS Web site provides an interface to determine GPS coordinates based on an address or map navigation at http://ddis.ifas.ufl.edu/gps/index.jsp.

Table 1. GPS-enabled Cameras, Devices, and Software for Geo-tagged Images

Device Name	Maker	Device	Note	Website
500 SE	Ricoh[tm]		GPS-ready digital camera Product Information	www.ricoh-usa.com
Nikon D90 Nikon D200 Nikon D300	Nikon[tm]		With GPS interface to connect to an external GPS accessory such as GP-1. Product Information (Read Review)	www.nikon.com
PhotoTrackr	GISTEQ[tm]		External device to synchronize with digital camera. Independent from digital camera makers. Product Information	www.gisteq.com
Alpha DSLR	Sony[tm]		Sony GPS-CS1 and GPS Unit Product Information	www.sony.com
Opanda PowerEXIF	Opanda[tm] Studio	Software	Software to read and modify EXIF metadata. Product Information	www.opanda.com
DDIS GPS	UF/IFAS	Web site	Provide GPS coordinates by navigating Google Maps	ddis.ifas.ufl.edu/gps/index.jsp

Note: The listed devices and trade markers are for illustration purpose only. This is not an endorsement by the author nor the University of Florida. Photos credit to the product manufactures respectively.

Metadata of JPEG Image Files

Exchangeable Image File Format (EXIF), created by the Japan Electronic Industry Development Association (JEIDA), is a specification for image file format used by digital cameras. EXIF is a variation of JPEG, which allows extra information to be recorded as metadata in the image file relates to camera setting, picture-taking condition, date and time, and most importantly, GPS information. The EXIF metadata is stored when a photo is taken. GPS information (latitude and longitude of where the photo is taken) is automatically stored into the image EXIF header for those GPS-enabled cameras such as the devices listed in Table 1. Alternately, EXIF metadata software is also available to modify digital photos to include metadata in the image files. Table

2 shows a sample EXIF header. A complete reference about the standard can be found by JEIDA. The standard ensures data compatibility and exchangeability.

Table 2. Sample Data of EXIF Metadata

	Tag Name	Value	Tag Name	Value
Image	Make	NIKON	Model	NIKON D90
	Orientation	Top/left	Software	Ver.1.00
	X Resolution	72	Y Resolution	72
	Date Time	2008-10-12 03:26:00		
Camera	Exposure Time	1/400'	F Number	F 5.6
	Exposure Program	Normal program	ISO Speed Ratings	100
	Exif Version	Version 2.21	Date Time Original	2008-10-12 03:26:00
	Date Time Modified	2008-10-12 03:26:00	Exposure Bias Value	±0EV
	Max Aperture Value	F4.14	Metering Mode	Pattern
	Light Source		Flash	Flash fired
	Focal Length	26mm	Maker Note	35010 Byte
	User Comment	DDIS Pest Sample	Subsec Time	
	Flashfix Version	Version 1.0	Color Space	sRGB
	Exif Image Width	3216	Exif Image Height	2136
	Sensing Method	One-chip color	File Source	DSC
	Scene Type	A directly photographed	Custom Rendered	Normal Process
	White Balance	Auto white balance	Digital Zoom Ratio	1x
	Focal Length in 35 mm File	39mm	Scene Capture Type	Normal
	Gain Control	Low gain up	Contrast	Normal
	Saturation	Normal	Sharpness	Normal
	Subject Distance Range	Unknown		
GPS	GPS Latitude Ref	North latitude	GPS Latitude	40°12'36"
	GPS Longitude Ref	West longitude	GPS Longitude	74°26'42"

Sample Map

The GPS-ready camera provides a new means to collect pest data and its location. With the readily availability of GPS coordinates and other metadata embedded in digital images, software can track where and when pest samples are collected. DDIS provides a module to extract the EXIF metadata to track pest samples. The mapping process can be performed seamlessly with integration mapping software such as Google Earth or Google Maps (Fig. 1). By leverage the Web mapping and digital imaging technologies, it could dramatically enhance our ability to track pests through time and space. Clearly, geo-tagged images have a great potential for many other geo-based applications.
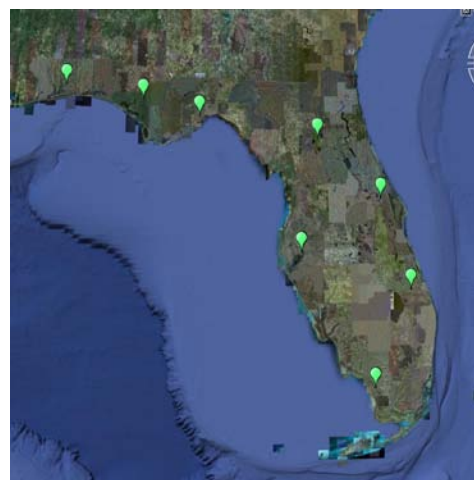

Figure 1. Tracking Pest Locations with Google Earth.