

## **IMAGINE Subpixel Classifier Version 8.4**

### **Product Information**

#### **Vendor:**

ERDAS, Inc.  
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Atlanta, GA 30329-2137  
404-248-9000 Fax: 404-248-9400  
[www.erdas.com](http://www.erdas.com)

**Release Date:** May 2000

### **Requirements**

#### **Software:**

ERDAS IMAGINE 8.4  
Microsoft Windows 98/NT 4.0 OS  
UNIX SunSPARC with Solaris 2.6/2.7 OS  
UNIX Silicon Graphics R4000 and higher with IRIX 6.5 OS

#### **Hardware:**

Windows OS:

Pentium CPU with Windows compatible CD-ROM and mouse  
45 MB RAM + 240 MB for ERDAS IMAGINE 8.4  
64 MB physical memory (128 MB recommended)  
250 MB of virtual memory  
Super VGA 1024 x 768 x 256 colors (64K colors recommended)

UNIX OS:

90 MB RAM + 240 MB for ERDAS Imagine 8.4  
64 MB physical memory (100 Mb recommended)  
200 MB swap space

#### **Cost:**

Commercial: (US) \$5,000, UNIX and Windows. International prices are 15% higher.

Educational: (US) \$1250, UNIX and Windows.

Volume discounts are also offered.

GSA pricing #GS – 35F – 0061K is also offered.

## Summary

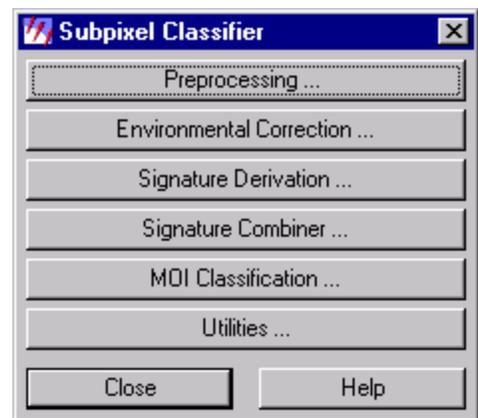
The IMAGINE Subpixel Classifier Version 8.4, developed by Applied Analysis Inc. (AAI) (Billerica, MA), is a fully integrated add-on application module to ERDAS IMAGINE 8.4 that is designed to detect materials within multispectral, mixed pixel situations. The IMAGINE Subpixel Classifier differs from both traditional classifiers and spectral mixing models in that rather than needing to specify  $n$  signature training sets that are derived of all the materials within a pixel, the IMAGINE Subpixel Classifier allows the user to develop a highly specific, whole or subpixel, spectral signature for a particular material of interest (MOI). This not only allows for the development of 'purer' signatures but by using an innovative background removal technique that removes all dissimilar materials from each pixel, results in a higher degree of discrimination sensitivity, and thus a classification of greater accuracy. The output is an overlay image indicating pixels containing the MOI in either two (.4 increments), four (.2 increments), or eight (.1 increments) classes, greater than 20 percent. The subpixel classification procedure is facilitated by a number of automated processes, including environmental correction that makes subpixel material detection easier, more accurate, and less time-consuming.

## Features

Seamlessly integrated with ERDAS IMAGINE 8.4, the IMAGINE Subpixel Classifier has a fully functional graphic user interface (GUI) which produces an overlay ERDAS IMAGINE image file indicating the subpixel occurrences of a specified MOI. The entire classification process consists of two optional and five required steps; of the five required, each must be completed before proceeding to the next:

*Data Quality Assurance.* Provided as an optional step for the identification of Duplicate Line Artifacts (DLAs) in older satellite imagery, this function assists in evaluating whether any information has been duplicated during resampling. As DLAs may potentially affect classification results, a DLA filter option is embedded within the Signature Derivation to automatically remove training pixels occurring within DLAs.

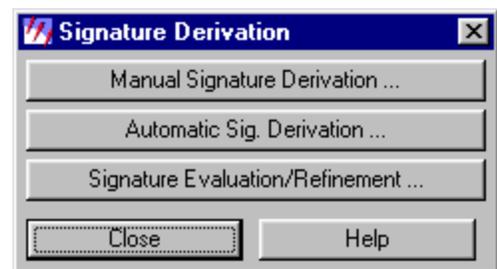
*Preprocessing.* A required, hidden step, this function autonomously surveys the image for background spectra to remove during signature derivation and MOI classification. The resultant file from this process is an *.aasap* file that is an associate file to the image file.



*Environmental correction.* A newly automated and required step, environmental correction calculates a set of factors to compensate for variations in atmospheric and environmental conditions during image acquisition. These correction factors are output to a .corenv file, which is then applied to the image during signature derivation and classification. This correction file not only calculates variances in reflected energy from the MOI in within-scene situations, but it also permits scene-to-scene transferability for signatures of differing dates and geographic regions. Cloud pixels may be indicated to exclude in the classification by way of a cloud selection file. Haze, or shadow, or non-responsive, or saturated pixels, may also be indicated to exclude from the correction process. The .corenv file is an ASCII text file that lists two correction spectra: the atmospheric correction factor (ACF) and the sun correction factor (SCF) for in-scene analysis, or the ACF and environment correction factor (ECF) for scene-to-scene analysis. These spectra may subsequently be evaluated based on the range of the digital numbers (DN) in each band.

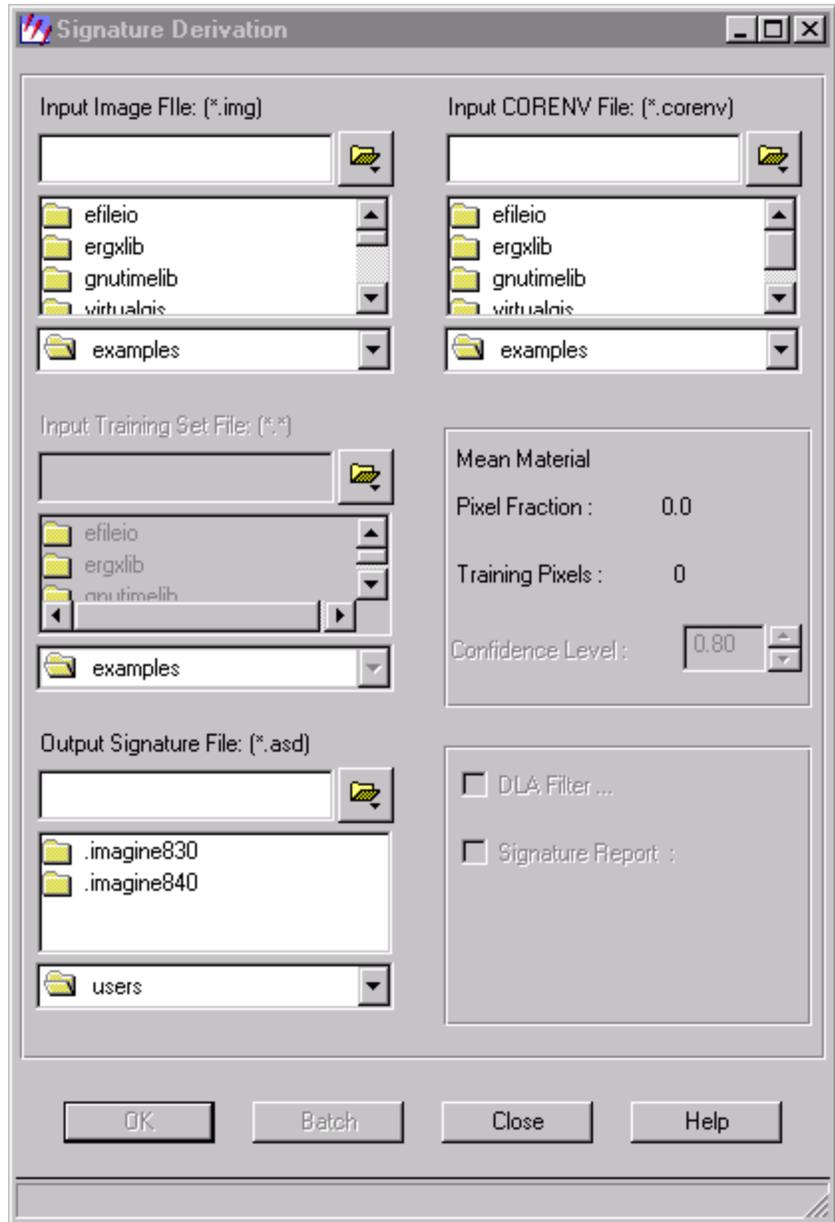


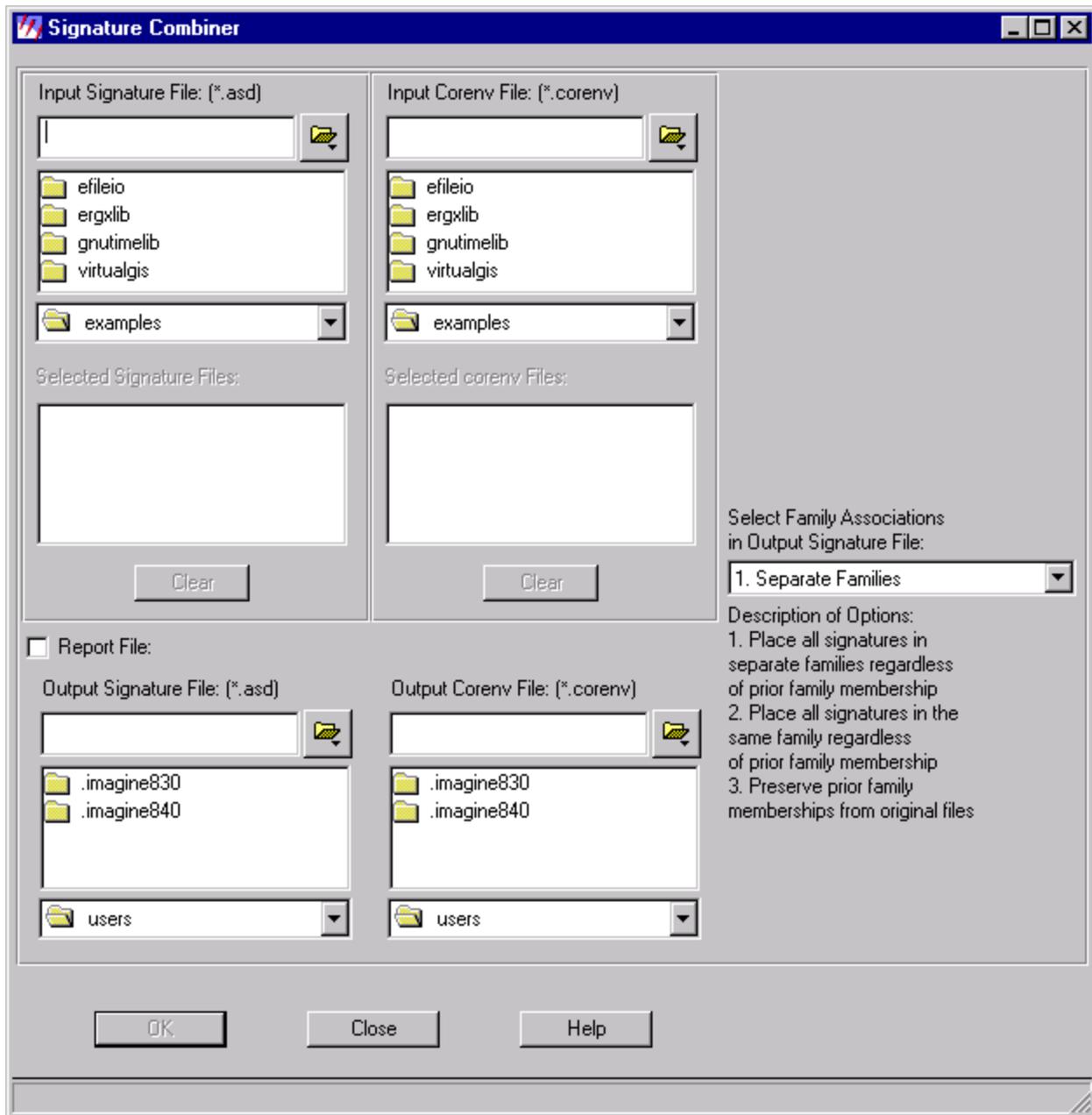
*Signature Derivation.* A required step, Signature Derivation allows the user to develop either a whole, or subpixel signature for a particular MOI. Manual Signature Derivation occurs by specifying either a whole-, or sub-pixel, training set defined by either an ERDAS IMAGINE Area of Interest (AOI), or a classification tool. The output signature file is created using this training set, along with the source image, the environmental correction file, and the material pixel fraction in the training set. The mean material pixel fraction is specified by the user and is the estimated fraction of the pixel's spatial area occupied by the MOI. In the instance of a subpixel training set, the process considers the material signature that is common to all pixels in the training set, resulting in an equivalent whole pixel signature. While there are a number of signature development strategies for both whole- and subpixel instances, it is recommended that whole-pixel signatures consisting of > 90% MOI be used.



There is also the option to derive a signature automatically, in which case the software will autonomously indicate the best signature from an AOI training set. This process is best used when the material pixel fraction in the training set is subpixel, or less than 90%. The user specifies both an AOI containing the MOI and an AOI containing false materials, utilizing the software to autonomously report the five best signatures corresponding to different material pixel fractions. These may be subsequently evaluated using the generated signature evaluation parameter (SEP), which measures the goodness of the signature. The output from Automatic Signature Derivation is a signature file (.asd file) and a signature description document (.sdd file), both of which may also be edited.

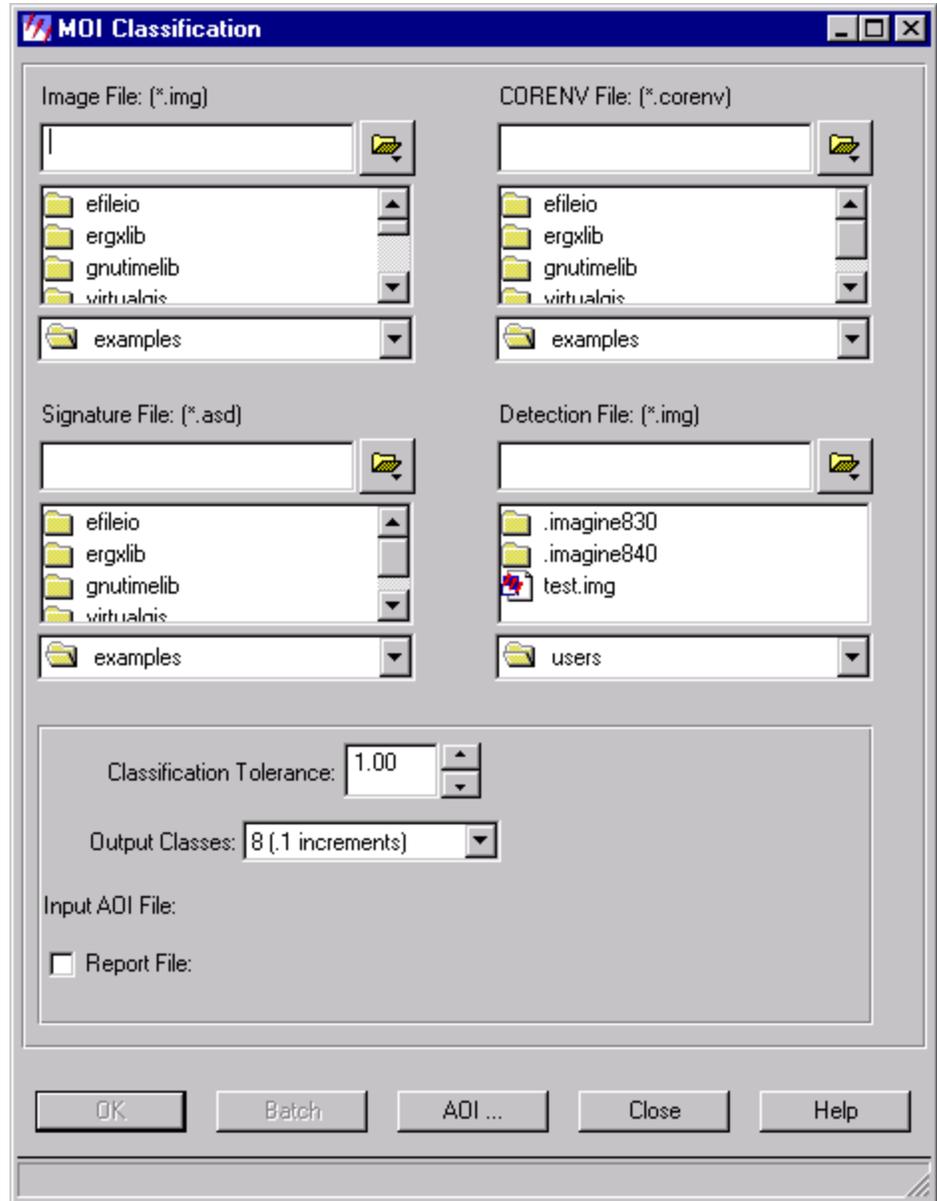
Signature Evaluation and Refinement is an optional process of Signature Derivation that allows the user to further improve classification performance in an iterative manner. Two separate functions are embedded within the Signature Evaluation and Refinement tool: Signature Evaluation Only (SEO) and Signature Refinement and Evaluation (SRE). SEO allows the user to compare the individual signatures in multiple signature files, and the SRE option allows the user to refine the existing input signatures by creating a new signature, and then evaluating the new signature as it compares to the original.





*Signature combiner.* An optional step, the Signature Combiner combines existing signatures and environmental correction factors for input into the final classification process. This feature is useful for those instances where the MOI can exhibit a range of reflectance characteristics, such as would occur in the seasonal variances of a plant species, as well as for those instances when the MOI consists of two or more co-existing characteristic materials, such as when the co-occurrence of a plant's leaves and seed pods elicit a more discriminating signature than would each alone. These can be grouped into a *signature family*, which is a collection of signatures representing variations in a single MOI. Whether or not a set of signatures is grouped as a family determines how the signatures are processed in Multiple Signature Classification. Here, signatures from different families are forced to compete against each other, whereas signatures grouped into families are treated independently during classification. It is also possible to combine a signature family with a different, unrelated signature. Multiple signature files are constructed using the Signature Combiner process, which allows the user to group associated signatures in a single classification run resulting in an output file that contains information for each signature processed. Signature Derivation generates a signature (.asd file) and a companion signature description document (.sdd file). The .sdd file contains parameters specific to the output signature file and can later be used to manipulate the MOI Classification output.

*Material of Interest classification.* In the final step in the IMAGINE Subpixel Classifier, MOI classification applies the signature(s) to an image to locate pixels containing the MOI or MOIs associated with the signature. The resultant output is an image (.img) file that contains the subpixel occurrences of the MOI, and may be viewed in the ERDAS IMAGINE Viewer like any other overlay image. The total number of pixels detected and the Material Pixel Fraction for each pixel classified are reported in the ERDAS IMAGINE Raster/Attribute Editor histogram. The user may select the output to be in two, four, or eight material pixel fraction classes. Selecting two classes will group the output into two 40% classes; 20-60% pixel fraction, and 60-100% pixel fraction. The default setting is eight classes, with pixels being output in eight bins of 10% increments, greater than 20%. Single signature classification results in an image (.img) file containing a single detection plane, while multiple signature classification results in an image file containing multiple detection planes, or layers; one for each individual signature in the multiple signature input file.



## Performance

This review was conducted on a 400 Mhz DELL Dimension XPS R400 with 128 Mb of RAM and operating under Windows 95 OS. Performance is a significant issue for large image datasets when using this module due to its high computational intensity. It is highly recommended that all suggestions be met regarding memory requirements.

May 8, 1995 Landsat Thematic Mapper (TM) data for the town of Waterford, Connecticut, were used for subpixel percent impervious surface cover quantification. The image was preprocessed in the first step of the IMAGINE Subpixel Classifier. Environmental correction was 'in scene', and no cloud pixels were selected. Three AOI files were created during manual signature derivation, each representing a discrete spectral class of imperviousness. These AOI files were then automatically converted to an .ats file, and saved as an output signature file (.asd). A confidence level of 0.90 was used for each of the MOIs. The three signature files were then combined into a family using the signature combiner, which then created an .asd and .corenv file for the family. MOI Classification was then utilized with the original TM image file, the family environmental correction file, and the family signature file. Eight output classes

were selected for the output (0.10 increments), with a specified classification tolerance of 1.60. MOI Classification resulted in a detection .img file that was comprised of four layers: one for each of the constituent AOI files in the family, and one for the combined contribution of these three layers. A subset of the composite image was then taken resulting in a final, 1-band thematic overlay layer.

Figure 1 shows the Waterford, Connecticut TM subset image in a 3, 2, 1 RGB color combination. Figure 2A shows the results of the MOI classification. Pixels containing impervious features exceeding 20% are ramped in 10% increments from yellow, indicating 20-30% imperviousness, to red, indicating 90-100% imperviousness. These classes are displayed in the Raster Attribute Editor, as is shown in Figure 2B.



**Figure 1.** LANDSAT TM scene, in a 3, 2, 1 RGB color combination of the town of Waterford, Connecticut.

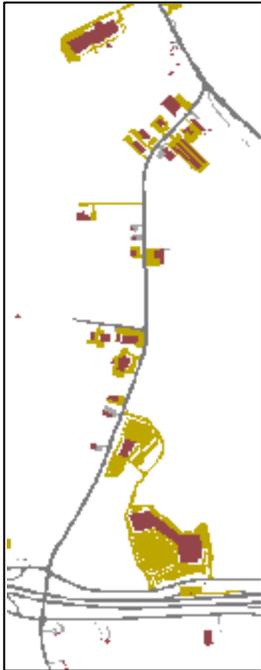


**Figure 2A.** IMAGINE Subpixel Classifier overlay image for impervious surfaces.

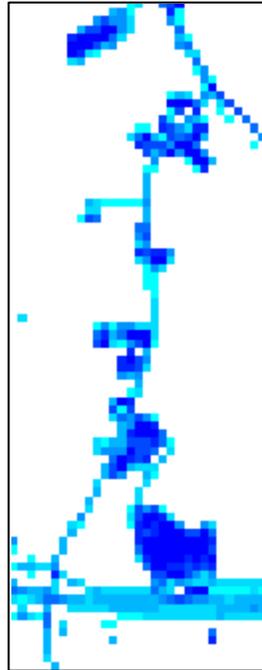
Row	Class Names	Histogram	Color	Red	Green	Blue	Opacity
0		0		1	1	1	0
1	0.20 - 0.29	129743	Yellow	1	1	0	1
2	0.30 - 0.39	188072	Light Orange	1	0.858824	0	1
3	0.40 - 0.49	196091	Orange	1	0.713725	0	1
4	0.50 - 0.59	146964	Dark Orange	1	0.572549	0	1
5	0.60 - 0.69	126714	Red-Orange	1	0.427451	0	1
6	0.70 - 0.79	135975	Red	1	0.286275	0	1
7	0.80 - 0.89	130780	Dark Red	1	0.141176	0	1
8	0.90 - 1.00	303862	Red	1	0	0	1

**Figure 2B.** ERDAS IMAGINE Raster Attribute Editor displaying IMAGINE Subpixel Classifier impervious surface detections greater than 20% subpixel occurrence in eight, 10% increment-classes.

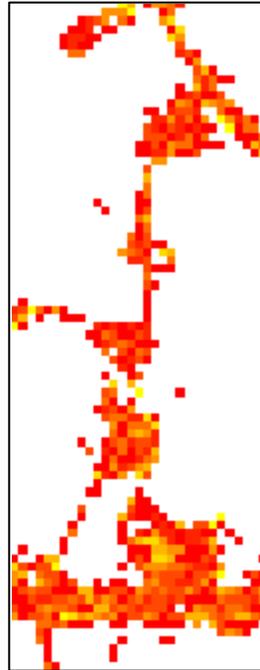
IMAGINE Subpixel Classifier output was qualitatively calibrated using 30m x 30m rasterized high-accuracy planimetric data. Figure 3A shows the impervious surface planimetric data for a detail of the above area of Waterford, Connecticut. Figure 3B shows the same data rasterized to 30m x 30m pixel size, corresponding to the pixel occurrences in the TM image. Figure 3C shows the IMAGINE Subpixel Classifier output for the same area, including some new development that occurred between the time of the TM image (1995) and the planimetric data (1994). Figure 3D shows the IMAGINE Subpixel Classifier output overlay upon the rasterized planimetric data.



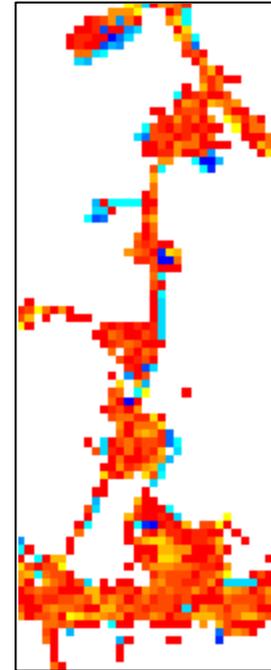
**Figure 3A.** Impervious surface planimetric detail for a small portion of Waterford, Connecticut.



**Figure 3B.** Planimetric detail rasterized to 30m x 30m pixel size.



**Figure 3C.** Impervious surface IMAGINE Subpixel Classifier output derived from Landsat Thematic Mapper.



**Figure 3D.** Impervious surface IMAGINE Subpixel Classifier output overlay with 30m x 30m rasterized planimetric layer.

Obtaining subpixel information from remote sensing data that are often of coarse resolution is a pervasive problem in the remote sensing community. As these results indicate, however, the IMAGINE Subpixel Classifier is very successful in extracting spectral signatures for specific materials. These results illustrate that the IMAGINE Subpixel Classifier offers a powerful complement to already existing classification tools.

### Documentation

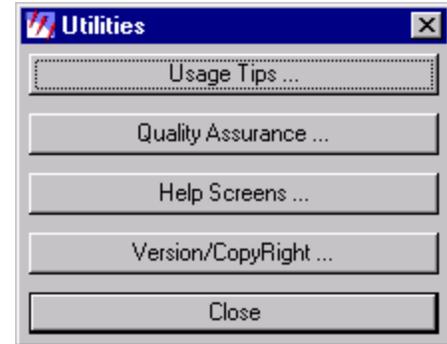
The documentation accompanying the IMAGINE Subpixel Classifier Version 8.4 consists of a Read Me file and a User's Manual containing six chapters, six appendices, and an index:

- Chapter 1: Introduction
- Chapter 2: Windows Installation and Configuration
- Chapter 3: UNIX Installation and Configuration
- Chapter 4: Getting Started with the Software
- Chapter 5: Step-by-Step Guide to Using IMAGINE Subpixel Classifier
- Chapter 6: Tutorial
- Appendix A: Glossary
- Appendix B: Tips on Using IMAGINE Subpixel Classifier
- Appendix C: Troubleshooting
- Appendix D: Interface with ERDAS IMAGINE
- Appendix E: User's Comment Form
- Appendix F: Software Support Request Form

Each chapter begins with an introduction and overview, followed by technical and applied aspects of the content addressed in each chapter. There are also a number of helpful icons in the User's Manual which indicate items of special interest, whether they be for tips or shortcuts, potential problems, reminders, or warnings.

IMAGINE Subpixel Classifier Help, separate from the Help offered by the main ERDAS IMAGINE Session Menu, is offered and may be accessed via the Help button provided in each dialog box, or via the on-line Help button available from the IMAGINE Subpixel Classifier main menu entitled 'Utilities'. Help offers step-by-step assistance on each topic, and there is a Help Contents option that allows for both hypertext links to various topics, and for searches through the index.

Applied Analysis, Inc. also has an Adobe Acrobat Portable Document Format (PDF) version of the manual on their website ([www.discover-aa.com](http://www.discover-aa.com)).



### Installation

Installation and configuration information is contained in the User's Manual for both UNIX and Windows environments. In both instances ERDAS IMAGINE must already be installed. As the IMAGINE Subpixel Classifier is an add-on module, if ERDAS IMAGINE is not installed, installation of the IMAGINE Subpixel Classifier will abort.

### Support

AAI offers free phone support to all customers, and ERDAS offers customers an annual support contract that includes maintenance, for 15% of retail. Much assistance – via telephone, email, and post – was given freely and promptly by both ERDAS and AAI in preparation for this review.

Mail support is offered in Appendix F of the User's Manual as a Software Support Request Form, which requests that a copy of the ERDAS IMAGINE session log be attached. There are also numerous contacts and support options available from both ERDAS and AAI's Web sites.

### Pros

The IMAGINE Subpixel Classifier provides a significant addition, and complement, to already existing classification methods as it allows analysts to derive more information from medium to coarse resolution satellite data, such as the Landsat sensors.

Because of its innovative background removal process, the IMAGINE Subpixel Classifier is not limited in the number of end-members it can analyze. Spectral Unmixing Models, a common approach to mixed pixel classification, are limited in their ability to analyze a number of end-members greater than  $n-1$  bands of the sensor. As a result, representative categories must be made in order to fully depict the heterogeneity of the landscape. In contrast, the IMAGINE Subpixel Classifier allows the user to develop highly specialized, transferable signatures of discrete materials. Should the analyst want to classify a number of spectrally dissimilar materials, the process would simply be done for each material.

### Cons

That the pixel values for the output thematic overlay image are placed in either two, four, or eight bins greater than 20% made any kind of calibration, or accuracy assessment, of the results somewhat difficult. This reviewer would have found it helpful were the continuous values produced for the MOI, per pixel. In this event, the user would be less limited in what post-processing can occur, and more able to calibrate the performance of the MOI signatures. Allowing a continuous output would also facilitate a number of applications in which the occurrence of materials, less than 20%, is precisely what information is sought.

This reviewer would also have found it helpful if signature files could have been used in the signature derivation process, rather than simply AOI files, or the results of a previous classification.

Lastly, as with most computer programs with a high degree of complexity, the IMAGINE Subpixel Classifier is computationally demanding and correspondingly, can be very time-consuming for large image files.

### **Recommendations**

Since it is a highly specialized product, the IMAGINE Subpixel Classifier has a very specific audience. The product is one of the few remote sensing image processing software solutions to resolve the mixed pixel effect, and hence perform subpixel classification. It is most ideally suited to those remote sensing technicians and scientists working with medium resolution data, such as Landsat TM, yet requiring information of a greater precision than provided typically at the whole pixel level.

The Web site at AAI (<http://www.discover-aa1.com/applicat.htm>) provides a number of application areas in which the IMAGINE Subpixel Classifier has been or could be used. Examples include subpixel crop identification in mixed fields, determining the degree of insect pest infestation, identification of specific tree species in complex forest environments, and others. These examples, as well as others described in white papers from AAI (<http://www.discover-aa1.com/whitepapers.htm>) provide insight as to how the IMAGINE Subpixel Classifier might, or might not, be the solution to one's mixed pixels problems.

The PE&RS paper "Subpixel Classification of Bald Cypress and Tupelo Gum Trees in Thematic Mapper Imagery," R. Huguenin, M. Karaska, D. Van Blaricom, and J. Jensen; *Photogrammetric Engineering & Remote Sensing* Vol. 63, pp. 717-725, June 1997 provides an overview of the fractional mapping method based on spectral unmixing. Lastly, it is suggested that the software developers' (ERDAS and AAI) recommended hardware and software configurations be exceeded for those potential users of the IMAGINE Subpixel Classifier who wish optimal performance.

### **Reviewed By**

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November 11, 2000