The Photointerpretation Workstation[†]

DOUGLAS LYON

Electrical, Computer, and Systems Engineering Department
Rensselaer Polytechnic Institute
Troy, New York 12180-3590

Abstract

A photointerpretation workstation based on the TI Explorer is described. Using object orientation and the flavor based menu system, a fast interactive means of performing computer vision research based on clique functions is provided.

[†]This work was supported in part by USAF RADC under Contract No. F30602-85-C-0008 and in part by NSF under Contract No. ECS81-13432.

I. Introduction

The photointerpretation workstation is an Explorer based AI tool for performing computer vision research on continuous tone images.

Our motivation for using the Explorer as a computational platform is based, in part, on the severe limitation in the data structures available in a FORTRAN programming environment. We have found that the traditional data processing environment to be too restrictive.

Our objective is to move to an environment with a rich set of data structures. With the Explorer as our target system, we hope to reap the benefits of programming using an object oriented paradigm.

II. Overview of PI Workstation

The Photo Interpretation Workstation (PIWS) is based on the TI Explorer. The PIWS is an interactive, fast, object oriented, dedicated, hybrid test bed for photointerpretation. The hybrid nature of the PIWS comes from the TMS32030 DSP chip which is capable of 20 MFLOP of throughput on vectorized operations. We feel that this will allow for fast segmentations. Because of the proliferation of Explorers within the NAIC, the PIWS should be readily portable.

III. User Interface

First, let's take a look at the programming environment. Using the flavor system, we are able to take advantage of the multiple-inheritance A.K.O. hierarchy. This enables us to program in a much more flexible fashion. For example, suppose that we wanted to define a flavor, we might use a form which is presented in Figure 1.

Here we can see that the user has defined a region flavor and made an instance of this flavor, called r1. This object, r1, may be sent a message, such as :area, and its area information is then returned. If we define a method, called :compactness, we may send the message, :compactness to the r1 instance, just as if it were an instance variable.

The message is treated differently, however, since every instance of the region flavor must calculate its own compactness from given instance variables.

This is a very general approach. Lets look at how this is applied to the clique function. Recall the clique function looks something like Figure 2. With corner points A,B,C, and D, the clique function flavor might look like Figure 3.

Here we see that the corner points become instance variables of the clique flavor. The user has created an instance of the clique flavor and set the atom c1 equal to it. It is possible to then define a method for the clique function which uses region based calculations to design its own corner points. In Figure 4, we see an example of the use of the clique flavor.

Here we see the true flexibility of the flavor system. We have defined a label flavor which contains a clique function for each feature. We broadcast to a list of regions the message feature[1] and then calculate the average of each-feature in the feature list. This is the returned as a list of feature averages whenever the label flavor is sent the :get-features message. This is of great assistance when designing clique functions.

IV. Status

The PIWS does not support image processing type hardware (yet). There is no color display, no continuous tone images, and no image digitization. Still we are able to display dithered images. The image in Figure 5 is displayed on a 700 by 700 pixel segment of the screen. The effective resolution is about 128 by 128 and up to 9 levels of grey are represented.

Using this technique we can also represent a segmented image as in Figure 6.

In Figure 7, we see a print made from the screen of the PIWS.

This PIWS frame is made up of five panes:

1. the "regions" pane,
2. the "labels" pane,
3. a "typeout window" pane,
4. the "PIWS Command Menu" pane and

[1]Here broadcast is a function which sends a message to each item in the list.

5. a "status of photo" pane.

In the "regions" pane we can see the name of the region[1] followed by an assigned interpretation label. This was assigned as a result of the annealing process. The first order energy level for the assignment follows with an overall energy for the label assignments at the bottom of the region pane. The features for each area are also present.

In the labels pane we see the clique functions with the weight for each of the assignments. Both panes are scroll windows and will scroll if the mouse is bumped up against the left hand side of the pane.

Each of the regions in the region pane is a mouse sensitive item. If the mouse comes near any of the items they are highlighted (this indicates that they are mouse sensitive). If the mouse is clique over region v2, the display results as in Figure 8.

Here we can see that the vegetation label is highlighted. This indicates the present computer interpretation. All of the items in this pop up menu are mouse sensitive and may be changed by the user. A similar technique is applied for the clique function pane as indicated in Figure 9.

V. Future Work

Currently, we input a symbolic description of the image. No segmentation is performed on the Explorer. We would like to perform all the photopreprocessing on the Explorer. This includes segmentation, histogram equalization, hand segmentation, hand interpretation, and image display. We feel that use of the TMS 32020 DSP will speed up the segmentation of the images.

[1]Note these names were assigned to a training image. They are the result of human interpretation.

The Programming Environment

- The Flavor System

  Using the flavor system:

```
(defflavor region
 (area  100)
  (.
   .
   .)
  ())

 (setq r1 (make-instance 'region))

 (send r1 :area)

 (defmethod (region :compactness) ()
  (....))
```

- This provides us with a flexible, object oriented data structure.

Figure 1

A Clique Function

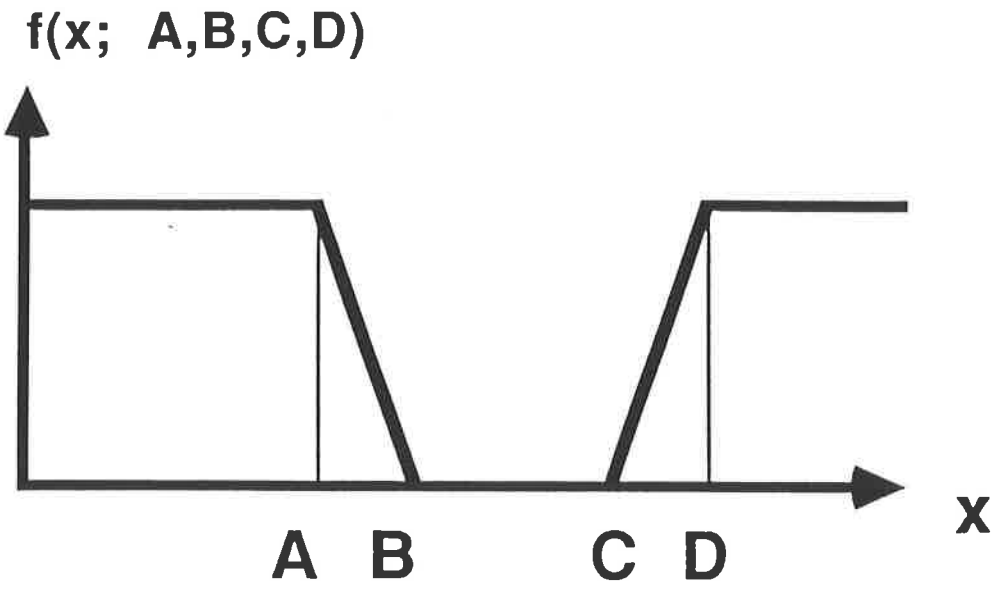

Figure 2

The Clique Flavor

```
(defflavor clique
 (a  0)
 (b  0)
 (c  0)
 (d  0)
  ( .
    .
    .)
   ())

(setq c1 (make-instance 'clique))
```

Figure 3

Using the Clique flavor

```
(setq grass (make-instance 'label))
 /* a human interpretation */
(send grass :add-regions r1 r2 r3...)
(send grass :add-clique c1)
(send grass :design-clique-function)

 (defmethod (label :design-clique-function)
            ( )
 (send self :get-features)
 (.....))

 (defmethod (label :get-features) ()
  (loop for each-feature in
       feature-list do
      (send each-feature :set-average
       (average
         (broadcast regions :feature))
```

Figure 4

Figure 5

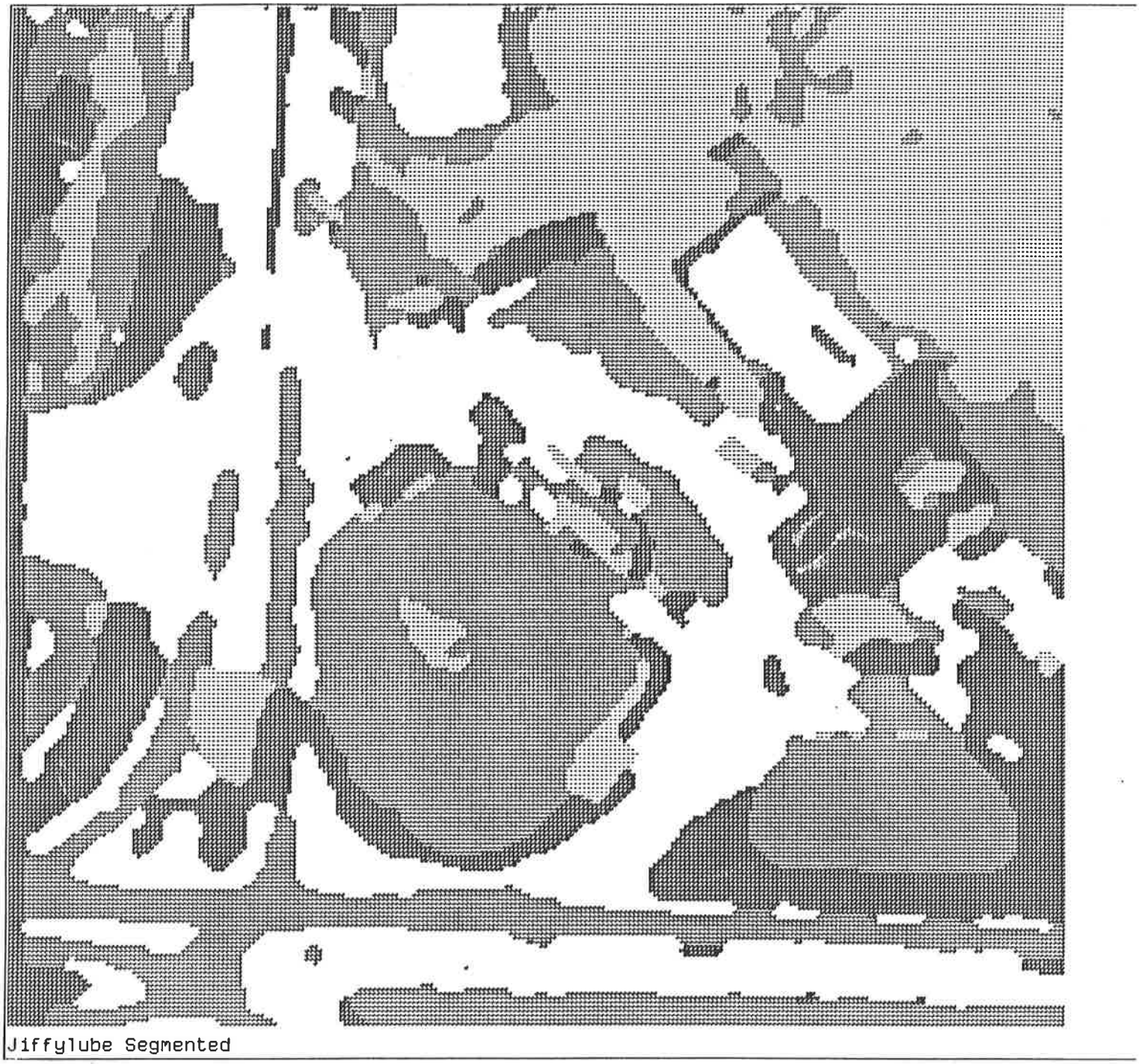

Figure 6

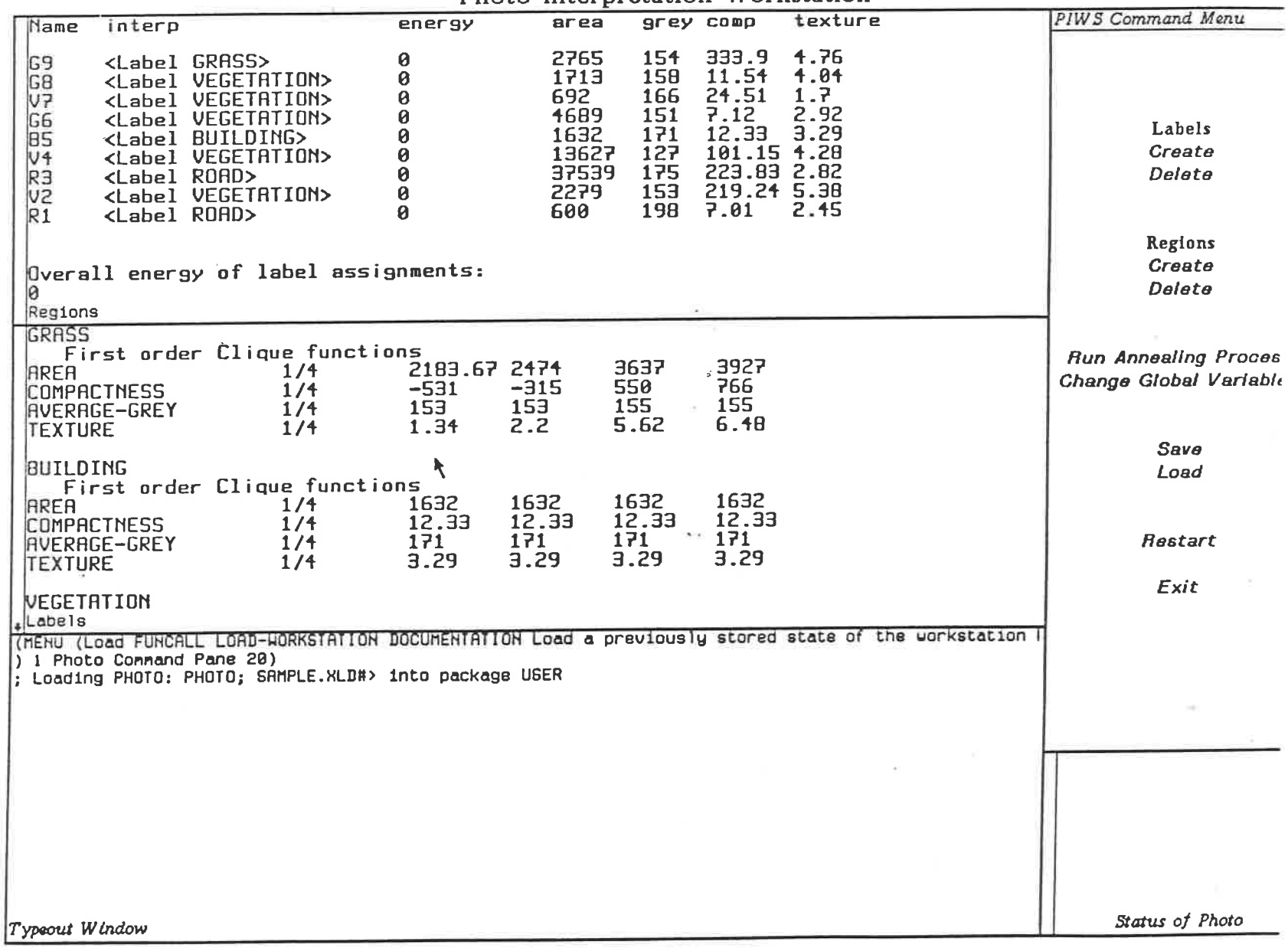
Photo Interpretation Workstation
Name interp energy area grey comp texture
G9 <Label GRASS> 0 2765 154 333.9 4.76
G8 <Label VEGETATION> 0 1713 158 11.54 4.04
V7 <Label VEGETATION> 0 692 166 24.51 1.7
G6 <Label VEGETATION> 0 4689 151 7.12 2.92
B5 <Label BUILDING> 0 1632 171 12.33 3.29
V4 <Label VEGETATION> 0 13627 127 101.15 4.28
R3 <Label ROAD> 0 37539 175 223.83 2.82
V2 <Label VEGETATION> 0 2279 153 219.24 5.38
R1 <Label ROAD> 0 600 198 7.01 2.45
Overall energy of label assignments:
0
Regions
GRASS
First order Clique functions
AREA 1/4 2183.67 2474 3637 3927
COMPACTNESS 1/4 -531 -315 550 766
AVERAGE-GREY 1/4 153 153 155 155
TEXTURE 1/4 1.34 2.2 5.62 6.48
BUILDING
First order Clique functions
AREA 1/4 1632 1632 1632 1632
COMPACTNESS 1/4 12.33 12.33 12.33 12.33
AVERAGE-GREY 1/4 171 171 171 171
TEXTURE 1/4 3.29 3.29 3.29 3.29
VEGETATION
Labels
(MENU (Load FUNCALL LOAD-WORKSTATION DOCUMENTATION Load a previously stored state of the workstation |
) 1 Photo Command Pane 20)
; Loading PHOTO: PHOTO; SAMPLE.XLD#> into package USER
Typeout Window
PIWS Command Menu
Labels
Create
Delete
Regions
Create
Delete
Run Annealing Proces
Change Global Variable
Save
Load
Restart
Exit
Status of Photo

Figure 7

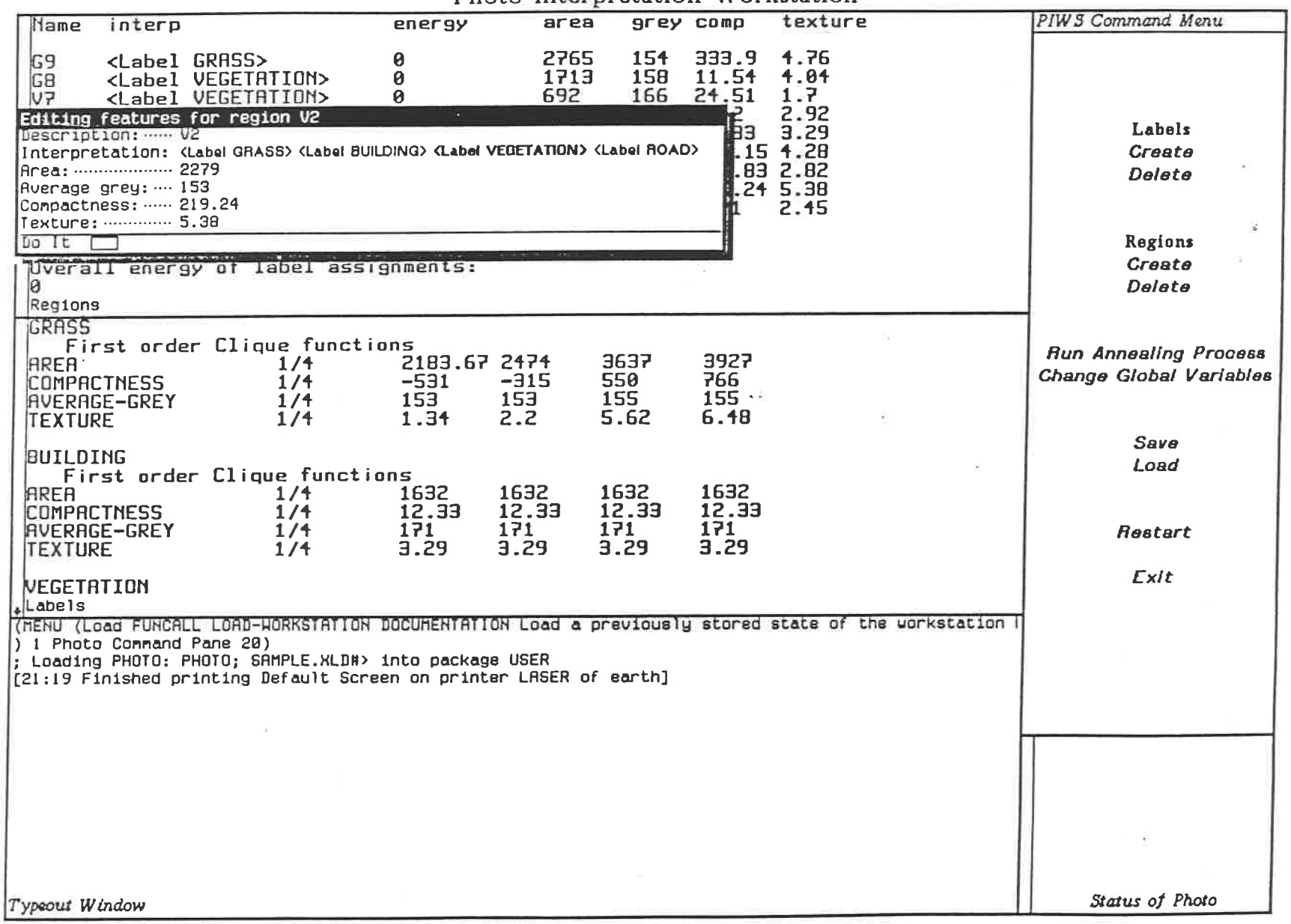
Photo Interpretation Workstation
Name interp energy area grey comp texture
G9 <Label GRASS> 0 2765 154 333.9 4.76
G8 <Label VEGETATION> 0 1713 158 11.54 4.04
V7 <Label VEGETATION> 0 692 166 24.51 1.7
Editing features for region V2
Description: V2
Interpretation: <Label GRASS> <Label BUILDING> <Label VEGETATION> <Label ROAD>
Area: 2279
Average grey: 153
Compactness: 219.24
Texture: 5.38
Do It
Overall energy of label assignments:
0
Regions
GRASS
First order Clique functions
AREA 1/4 2183.67 2474 3637 3927
COMPACTNESS 1/4 -531 -315 550 766
AVERAGE-GREY 1/4 153 153 155 155
TEXTURE 1/4 1.34 2.2 5.62 6.48
BUILDING
First order Clique functions
AREA 1/4 1632 1632 1632 1632
COMPACTNESS 1/4 12.33 12.33 12.33 12.33
AVERAGE-GREY 1/4 171 171 171 171
TEXTURE 1/4 3.29 3.29 3.29 3.29
VEGETATION
Labels
(MENU (Load FUNCALL LOAD-WORKSTATION DOCUMENTATION Load a previously stored state of the workstation I
) 1 Photo Command Pane 20)
; Loading PHOTO: PHOTO; SAMPLE.XLD#> into package USER
[21:19 Finished printing Default Screen on printer LASER of earth]
Typeout Window
PIWS Command Menu
Labels
Create
Delete
Regions
Create
Delete
Run Annealing Process
Change Global Variables
Save
Load
Restart
Exit
Status of Photo

Figure 8

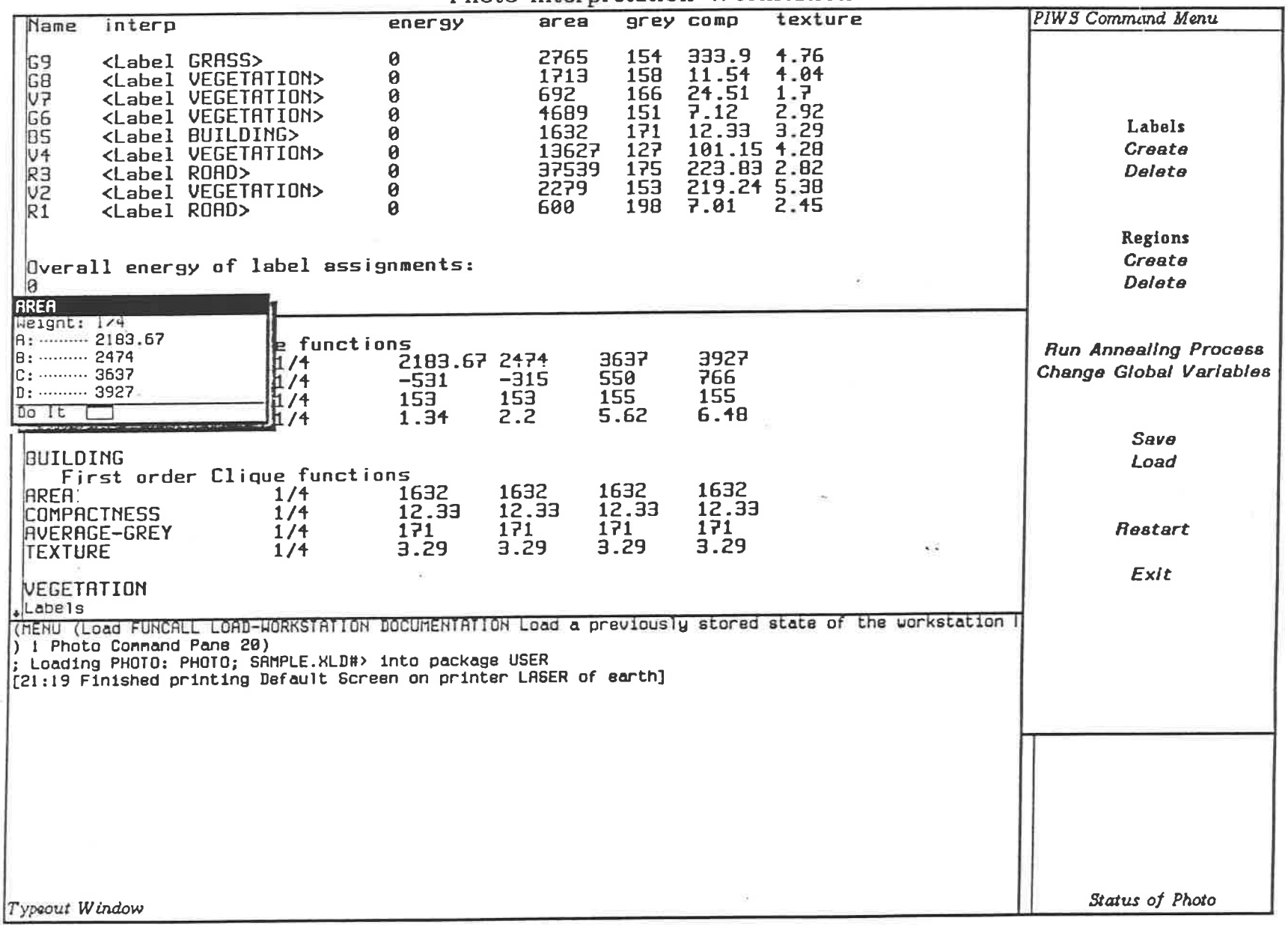
Photo Interpretation Workstation
Name interp energy area grey comp texture
G9 <Label GRASS> 0 2765 154 333.9 4.76
G8 <Label VEGETATION> 0 1713 158 11.54 4.04
V7 <Label VEGETATION> 0 692 166 24.51 1.7
G6 <Label VEGETATION> 0 4689 151 7.12 2.92
B5 <Label BUILDING> 0 1632 171 12.33 3.29
V4 <Label VEGETATION> 0 13627 127 101.15 4.28
R3 <Label ROAD> 0 37539 175 223.83 2.82
V2 <Label VEGETATION> 0 2279 153 219.24 5.38
R1 <Label ROAD> 0 600 198 7.01 2.45
Overall energy of label assignments:
0
AREA
Weight: 1/4
A: 2183.67
B: 2474
C: 3637
D: 3927
Do It
e functions
1/4 2183.67 2474 3637 3927
1/4 -531 -315 550 766
1/4 153 153 155 155
1/4 1.34 2.2 5.62 6.48
BUILDING
First order Clique functions
AREA 1/4 1632 1632 1632 1632
COMPACTNESS 1/4 12.33 12.33 12.33 12.33
AVERAGE-GREY 1/4 171 171 171 171
TEXTURE 1/4 3.29 3.29 3.29 3.29
VEGETATION
Labels
(MENU (Load FUNCALL LOAD-WORKSTATION DOCUMENTATION Load a previously stored state of the workstation |
) 1 Photo Command Pane 20)
; Loading PHOTO: PHOTO; SAMPLE.XLD#> into package USER
[21:19 Finished printing Default Screen on printer LASER of earth]
Typeout Window
PIWS Command Menu
Labels
Create
Delete
Regions
Create
Delete
Run Annealing Process
Change Global Variables
Save
Load
Restart
Exit
Status of Photo

Figure 9