PAVIS User Manual

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A brief user introduction to the Pulp Automated Visual Inspection System (PAVIS) prototype

Introduction

Welcome to *PAVIS*, the Pulp Automated Visual Inspection System. This system was developed to automate the task of visually inspecting pulp. The system captures digital images of pulp and then analyzes these images to determine the quality of the pulp. This document explains the use of the PAVIS system. The chapters are organized as follows:

- Chapter 1 defines the system's requirements in terms of software and hardware, and describes the system configuration.
- Chapter 2 gives an overview of the entire inspection system. The inspection procedure is described and the various system features are explained.
- Chapter 3 covers the reporting aspect of the system. The textual output from the program is discussed.

This system is still in a prototype stage and it is not a fully automated inspection system at this point.This manual provides the user with a full description of the use of the current system.

1.0 Getting Started

1.1 Hardware Requirements

The PAVIS system is composed of the following pieces of hardware:

- Pentium 100MHz computer with 16 Meg RAM and 1 Gig hard drive.
- Bitflow Raptor Video Capture Board.
- PULNiX TM-9700 camera. This is a high resolution (768H x 484V) full frame shutter camera with asynchronous reset capability. The camera employs a substrate drain type shutter which allows a shutter rate of between 1/60 and 1/16000 seconds.
- 12.5-75mm Cosmicar TV zoom lens.
- QuadTech Stroboslave

1.2 Software Requirements

The PAVIS system is written in C/C++ and using the following software:

- Microsoft Visual C++ version 1.5.
- Microsoft Windows version 3.1.
- Bitflow Raptor Software Development Kit.

1.3 System Configuration

NOTE: This section should contain a description of the system configuration. This should reflect the final set up in which the camera, strobe, and software are working together. The system configuration has not been determined at the time of writing.

2.0 Using Inspection System

2.1 Overview

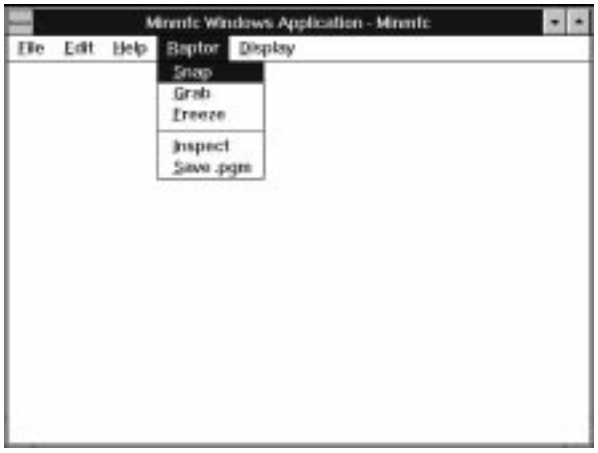
The inspection procedure can be summarized in the following steps.

1. **Calibrate the system**: Steps 2 to 4 are repeated until the system is calibrated to it's inspection environment.
2. **Image Acquisition**: Acquire an digital image for inspection.
3. **Image Inspection**: The software inspects/analyzes the image.
4. **Examine results**: The results can be examined both visually, and by inspecting the reports produced. If the desired results are not obtained, the user can modify the inspection parameters and repeat steps 2 to 4.

The following sections discuss the use of the PAVIS system in inspecting digital pulp images.

2.2 Image Acquisition

The PAVIS application can be started by double clicking the mouse on the file *c:/dimian/pulp/minmfc/minmfc.exe*. A Windows application window will appear that looks like the one shown below. The first step in the inspection process is the acquisition of an digital image of the pulp.

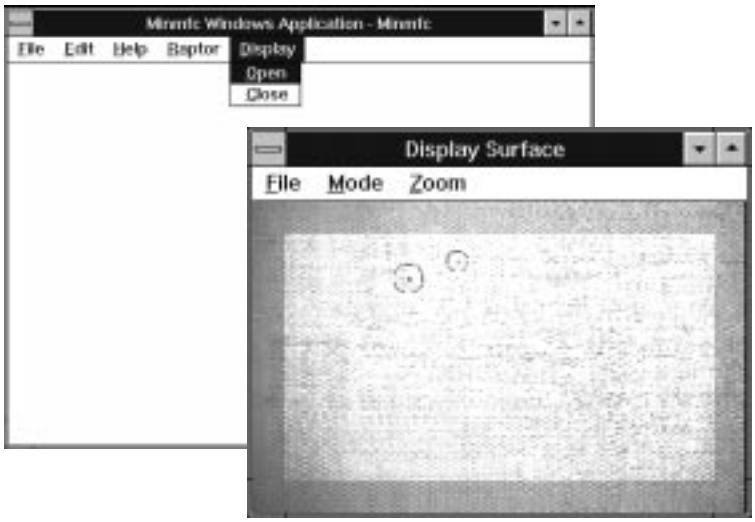


This image can be captured by selecting the **snap**, **grab**, or **freeze** options under the **Raptor** menu. These 3 options (or modes) act in the following manner:

- **Snap** will capture a digital image of what the camera is looking at, at that instant in time. Only this image will be displayed. The capture board is still active and the snap command can be issued
- **Grab** will continuously capture images. The video capture board is constantly being updated. This is mode is useful for monitoring the motion of the camera or pulp.

- **Freeze** works in a similar fashion as the snap command. It displays only the image acquired at that instant in time. It is different that the snap command in that it freezes the capture board so that it will not longer be updated.

We will discuss these acquisition modes again in section 2.5: Displaying Inspection Results. If you try selecting any of these options at this time you will realize that nothing seems to be happening. This is because we do not have a window open to view the captured image. Try selecting the **Open** option under the **Display** menu as is show below.



This will bring up a display window in which you can view the captured images. Now try experimenting with the **snap**, **grab**, and **freeze** options in the **Raptor** menu.

2.3 Image Inspection

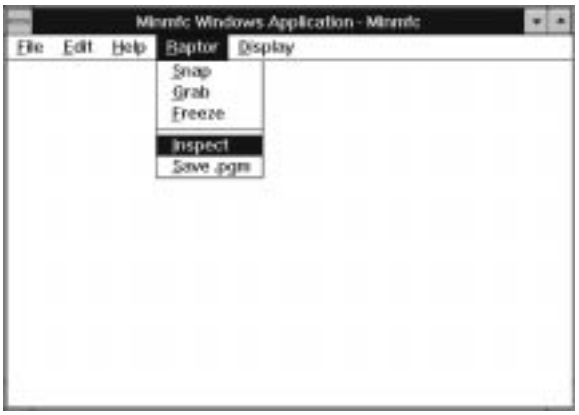
Once an image is obtained, the software inspection phase begins. The software analyzes the image for defects by detecting variations in the grey levels of the pixels. The inspection process checks for two types of irregularities or defects[1].

1. **Dirt**. Areas with a pixel value lower (darker) than the calculated threshold. This type of defect is typically very dark with a much smaller connected area than talc.
2. **Talc**. This type of defect is distinguished from dirt by a larger connected area and by a lower (lighter) average grey level.

The image in figure 2 has been inspected by the software. The circles indicate where areas of dirt were detected. Later on we will see what parameters are specified by the user in the inspection process.

1. The current prototype only detects *dirt* type defects in the pulp.

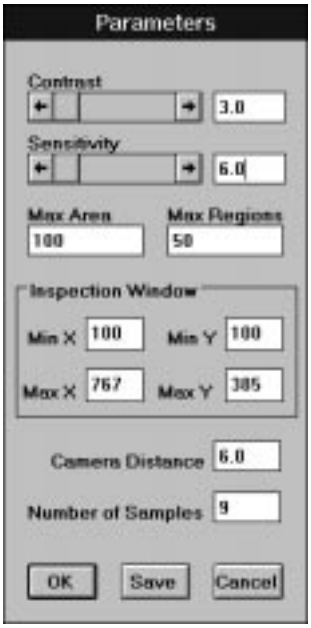
The captured image can be inspected by selecting the **Inspect** option from the **Raptor** menu below:



The inspected image should now appear in the Display Surface window. The defective regions should be circled. If the inspection does not appear to have worked properly, it is likely that the inspection parameters have not been set properly. The following section will discuss the user definable inspection parameters.

2.4 Parameters

The PAVIS system must be calibrated to the it's inspection environment. This calibration requires that several inspection parameters be set by the user. The parameter interface can be brought up my clicking on the left mouse button. The parameter interface panel shown below should appear when the left mouse button is pressed.



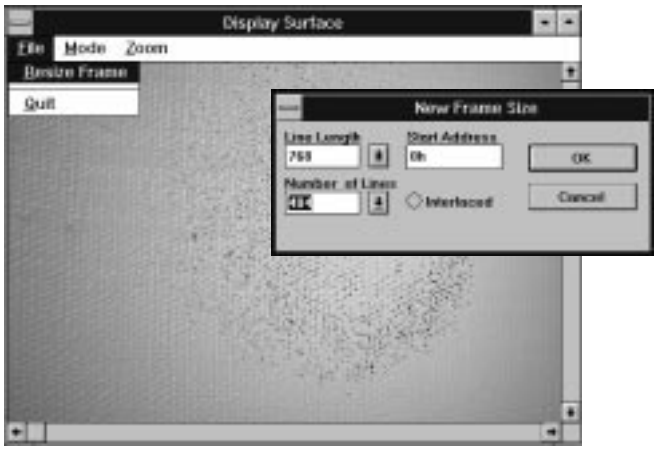
The system reads in the parameters from a file that contains the defaults from the last time the system was used (or from the last time the parameters were set using the parameter interface.). Table 2 below lists the parameters used by the software along with some comments on their use.

TABLE 1. Inspection Parameters

Parameter	Description	Comments on use
Contrast	Used to determine the upper end (maximum value) to use in the stretch of the grey level histogram.	Value range of 0.0 to 10.0
Sensitivity	Used to determine the threshold value. Any grey level pixels with a grey level lower than this threshold are considered “dirty” pixels.	Value range of 0.0 to 10.0
Xmin,Ymin, Xmax,Ymax	These represent the minium and maximum x,y coordinates that correspond to the area of the image to be examined.	The default values correspond to the entire image.
Max Regions	Specifies the maximum number of connected regions that are allowed. It is used to provide a warning of possible camera misalignment. If the maximum number of regions is surpassed, this may indicate a need for re-calibration.	Must be less than the area of the image divided by the
Samples	Specifies the number of samples to use in calculating the running average and other statistics that are written to a log file.	
Camera Distance	Specifies the distance from the camera lens to the surface of the pulp to be inspected.	
Max Area	Specifies the maximum area (connected region) that can be “dirty”. If this value is surpassed, this may indicate a need for re-calibration.	Must be less than the area of the image.

2.5 Displaying Inspection Results

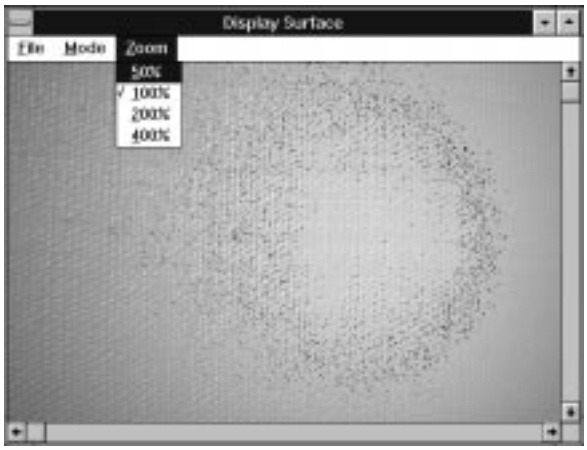
As we have already seen, the inspection results can be seen in a Display Surface window. The detected dirty regions are circled. The inspection window can be resized by selecting the **Resize Frame** option under the **File** menu. This will bring up a new window with the title *New Frame Size* as is shown below.



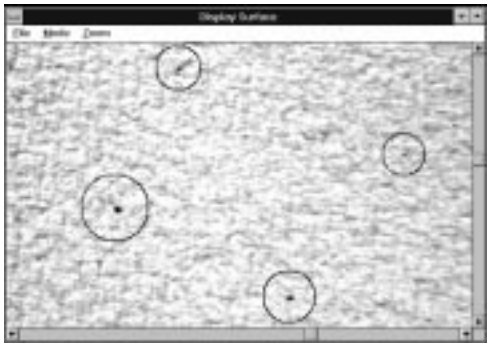
To change the size of the display window, simply select the **Line Length** (width) and the **Number of Lines** (height), and then click on the **OK** button. The Display Surface window has 2 modes of operation:

- **Update Display**: In this mode the Display Surface window is only updated when the user selects the Update Display option from the Mode menu. The Display Surface can be updated by the user as often as desired. The user can switch to a continuous update mode by selecting the Continuous Update option. (See below.)
- **Continuous Update**: In this mode the Display Surface is constantly being updated by the video capture board. If this mode is used in conjunction with the Grab option from the Raptor menu in the Minmfc window, the Display Surface window will function as a live video monitor. The user can switch back from Continuous Update by selecting the Stop Updating option from the Mode menu. (See below.)

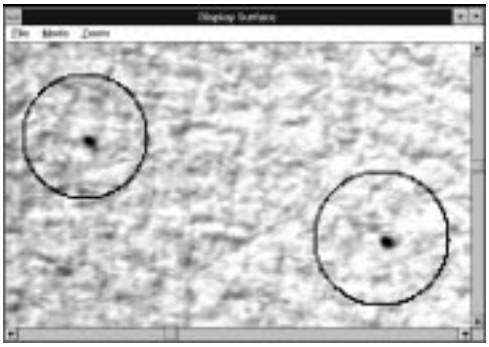
If the user requires a more detailed view of the inspected image, the Zoom Option can be used to enlarge the image in the Display Surface window. Try making a selection from the Zoom menu as shown below.



The two images below show the effects of selecting the 200% and 400% options from the Zoom menu.



200%

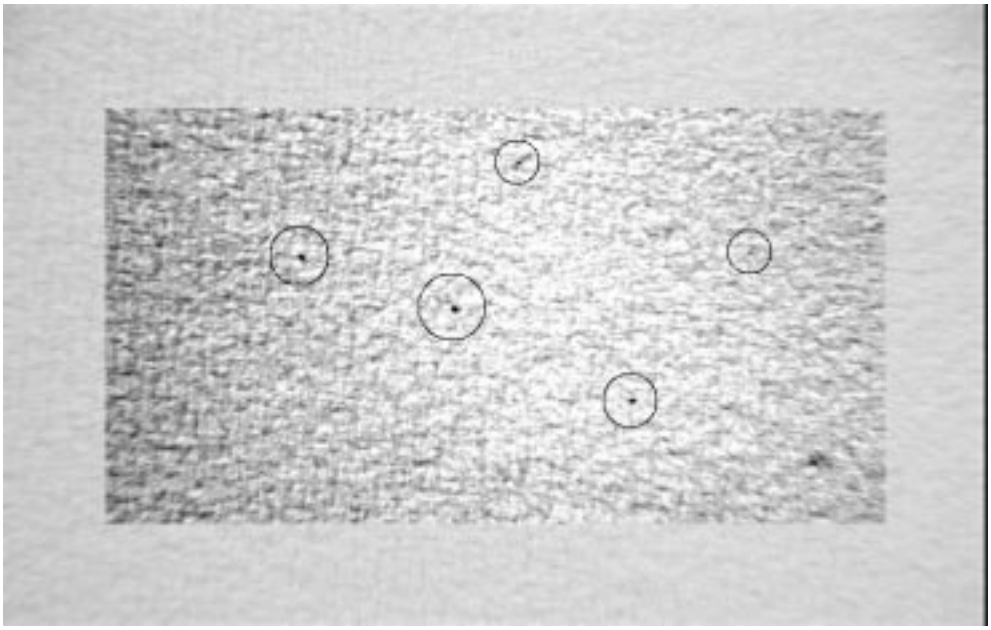


400%

3.0 Image Analysis

3.1 Inspected Image

The captured digital images are inspected by the software. Any dirt in the image is circled as is shown below. The size of the circles is dependant on both the size (area) and darkness (grey level) of the region of dirt.



The dark spot in the lower right hand corner has been missed on purpose. This dark area is in fact a shadow caused by the front lighting used to capture this image. Although it is difficult for the human eye to detect in this image, this spot is not as dark as the circled areas. The sensitivity parameter in the system has been set so that the dirt is detected, yet shadows are ignored.

3.2 Reports

Should discuss the reporting/archiving needs with the pulp mill. This section will describe and give examples of:

1. Reporting - Periodic status reports (ex. weekly), appended results reports (daily)
2. Archiving - compressed images, reports, etc.

A report is printed out for each image inspected by the system. Reporting at this point consists of information useful to system development. A sample report is shown below:

```
Report re131508.txt
Date: 07/26/95
Time: 13:15:08
```

```
Parameters:
 camera dist = 80.0000
 contrast = 6.0000
 sensitivity = 6.4000
 T = 12

Region 0:
 Area (pixels) = 2
 Average value = 0.00

Region 1:
 Area (pixels) = 1
 Average value = 0.00

Region 2:
 Area (pixels) = 8
 Average value = 1.13

Region 3:
 Area (pixels) = 11
 Average value = 1.18

Region 4:
 Area (pixels) = 5
 Average value = 4.97

Total Area = 27
Average value = 0.2695
```

3.3 Log Files

Log files are similar to reports in the sense that they are textual records of the inspection of images. Unlike the reports, a log file is not generated for every image inspected. The log files are used to record the statistics of the inspection of many images of pulp. The **Samples** parameter is used to determine the number of samples that will be used to determine the quality of a number of images. Log files are used to record the inspection statistics for the set of samples (images) to monitor changes in the quality of pulp over time.

Although some code has been written to produce log files, this will have to be customized to the needs of the pulp mill. As such, this is not complete at this point.