

```

shell@ ~ - /bin/bash
N Compiled module: ZLIB.
N Compiled module: READER_COMPILED.
N Compiled module: ZLIB_C.
N Compiled module: ARG_COMPILED.
shell@ ~$ run
N Compiled module: ROTTERD.
N Compiled module: ROTTERD.
Left button to mark point
Middle button to erase previous point
Right button to close region

Computing the weighted centroid
The range of latitudes being used is: 237, 2552
The weighted centroid appears at latitude: 223.8888, 287.3888

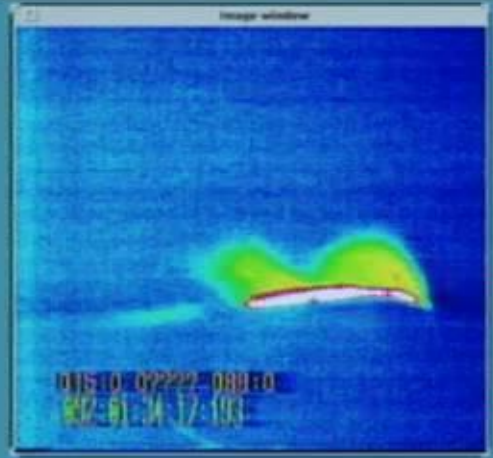
Press left mouse button for zoom center
--- center mouse button for new zoom factor
--- right mouse button to exit.

```

```

Select options
Use three values and buttons to mark area
Create an additional one for this image
Increase selected range for finding centroid
Newline region of interest
Display all core locations for this image
Exit the program

```



1
00:00:42,160 --> 00:00:40,420
this video supplement is composed of

2
00:00:45,670 --> 00:00:42,170
eight sequences each of which is

3
00:00:48,160 --> 00:00:45,680
referenced in the report these dynamic

4
00:00:50,200 --> 00:00:48,170
demonstrations primarily of f-106 being

5
00:00:52,510 --> 00:00:50,210
flight vapor screen images obtained

6
00:00:54,340 --> 00:00:52,520
using a rotating light sheet have been

7
00:00:56,260 --> 00:00:54,350
designed to provide insight into the

8
00:00:58,720 --> 00:00:56,270
process of developing quantifiable

9
00:01:00,340 --> 00:00:58,730
results from this data for a complete

10
00:01:02,530 --> 00:01:00,350
description of the image data is

11
00:01:04,810 --> 00:01:02,540
analysis and the analyses of other types

12
00:01:14,410 --> 00:01:04,820
of data as well the formal document

13
00:01:18,429 --> 00:01:16,780

this flight experiment was done in order

14

00:01:20,499 --> 00:01:18,439

to examine vortical flow field

15

00:01:24,910 --> 00:01:20,509

characteristics on a highly swept wing

16

00:01:27,280 --> 00:01:24,920

at full-scale flight conditions an F

17

00:01:28,840 --> 00:01:27,290

106b fighter interceptor airplane was

18

00:01:30,880 --> 00:01:28,850

chosen because of its wide flight

19

00:01:32,560 --> 00:01:30,890

envelope allowing data to be gathered

20

00:01:34,980 --> 00:01:32,570

over a range of angles of attack and

21

00:01:37,539 --> 00:01:34,990

Mach numbers as well as reynold numbers

22

00:01:39,730 --> 00:01:37,549

the test aircraft was outfitted with

23

00:01:42,539 --> 00:01:39,740

flow visualization equipment adapted

24

00:01:44,590 --> 00:01:42,549

from wind tunnel experimentation a

25

00:01:46,630 --> 00:01:44,600

rotating thin sheet of light was

26
00:01:48,550 --> 00:01:46,640
produced by a mercury arc lamp with a

27
00:01:50,109 --> 00:01:48,560
slit and lens arrangement this

28
00:01:52,059 --> 00:01:50,119
illumination permitted the general

29
00:01:54,460 --> 00:01:52,069
characteristics of the vortex made

30
00:01:56,469 --> 00:01:54,470
visible by an trained seated vapor to be

31
00:01:59,649 --> 00:01:56,479
recorded by two video cameras focused

32
00:02:01,330 --> 00:01:59,659
over the wings upper surface flight

33
00:02:03,309 --> 00:02:01,340
planning to obtain desired flight

34
00:02:06,039 --> 00:02:03,319
conditions resulted in two types of

35
00:02:07,960 --> 00:02:06,049
maneuvers 1g flight at various speeds

36
00:02:12,400 --> 00:02:07,970
and altitudes and descending spiral

37
00:02:14,800 --> 00:02:12,410
turns meteorological conditions were a

38
00:02:17,020 --> 00:02:14,810

chief limiting constraint test

39

00:02:19,030 --> 00:02:17,030

instrumentation onboard the aircraft was

40

00:02:21,610 --> 00:02:19,040

restricted from flight through clouds or

41

00:02:23,380 --> 00:02:21,620

precipitation flights could only be made

42

00:02:25,000 --> 00:02:23,390

at night during periods of no moon

43

00:02:28,780 --> 00:02:25,010

elimination to ensure sufficient

44

00:02:30,250 --> 00:02:28,790

contrast to the video cameras the light

45

00:02:32,050 --> 00:02:30,260

sheet and vapor generator were

46

00:02:34,990 --> 00:02:32,060

controlled by an engineer in the aft

47

00:02:37,390 --> 00:02:35,000

cockpit a video display showed the image

48

00:02:40,360 --> 00:02:37,400

from either camera along with angle of

49

00:02:42,039 --> 00:02:40,370

attack and light sheet position flight

50

00:02:44,020 --> 00:02:42,049

data were recorded on board and

51
00:02:46,780 --> 00:02:44,030
telemetered to a ground station at NASA

52
00:02:49,479 --> 00:02:46,790
Langley the primary data collected was

53
00:02:51,490 --> 00:02:49,489
video at night the wing was not visible

54
00:02:53,170 --> 00:02:51,500
and only the light sheet and vapor

55
00:02:56,199 --> 00:02:53,180
cross-section over the wing could be

56
00:02:58,240 --> 00:02:56,209
seen on point data collection proceeded

57
00:03:00,460 --> 00:02:58,250
with a light sheet sweep across the wing

58
00:03:02,849 --> 00:03:00,470
as well as several discrete light sheet

59
00:03:04,509 --> 00:03:02,859
locations for post flight analysis

60
00:03:06,819 --> 00:03:04,519
additional flights were made during

61
00:03:17,270 --> 00:03:06,829
daylight with an oil mixture painted on

62
00:03:22,400 --> 00:03:20,150
an integrated computer process combining

63
00:03:24,230 --> 00:03:22,410

image processing computer graphics and

64

00:03:26,260 --> 00:03:24,240

photogrammetric reconstruction

65

00:03:28,190 --> 00:03:26,270

techniques was utilized to aid in

66

00:03:30,020 --> 00:03:28,200

three-dimensional visualization of

67

00:03:32,750 --> 00:03:30,030

images produced by the rotating light

68

00:03:34,670 --> 00:03:32,760

sheet accurate surface definition of the

69

00:03:36,979 --> 00:03:34,680

aircraft was simulated through original

70

00:03:38,990 --> 00:03:36,989

engineering drawings including geometric

71

00:03:41,000 --> 00:03:39,000

description of wings fuselage and

72

00:03:42,650 --> 00:03:41,010

vertical tail all of which were

73

00:03:44,890 --> 00:03:42,660

collectively rendered to produce a

74

00:03:47,240 --> 00:03:44,900

smooth three-dimensional model an

75

00:03:49,699 --> 00:03:47,250

additional input into this environment

76
00:03:51,320 --> 00:03:49,709
was a set of parameters describing the

77
00:03:56,150 --> 00:03:51,330
placement of the two cameras on board

78
00:03:58,250 --> 00:03:56,160
the f-106 be several targets were placed

79
00:03:59,720 --> 00:03:58,260
upon the wing upper surface and record

80
00:04:02,479 --> 00:03:59,730
that's measured to facilitate the

81
00:04:04,160 --> 00:04:02,489
calibration of the cameras the WHA video

82
00:04:06,020 --> 00:04:04,170
footage captured by the cameras in

83
00:04:07,820 --> 00:04:06,030
flight provided only qualitative

84
00:04:11,360 --> 00:04:07,830
information as to the size and placement

85
00:04:13,430 --> 00:04:11,370
of vortices above the wing each image

86
00:04:15,110 --> 00:04:13,440
had a perspective distortion produced as

87
00:04:17,870 --> 00:04:15,120
the light sheet rotates away from the

88
00:04:20,120 --> 00:04:17,880

stationary cameras to account for these

89

00:04:22,039 --> 00:04:20,130

irregularities and extract quantitative

90

00:04:24,380 --> 00:04:22,049

geometric information from the images a

91

00:04:27,080 --> 00:04:24,390

photogrammetric reconstruction technique

92

00:04:29,210 --> 00:04:27,090

was developed this technique map each

93

00:04:31,130 --> 00:04:29,220

point in the image plane of a camera to

94

00:04:34,040 --> 00:04:31,140

a precise location in the plane of the

95

00:04:35,659 --> 00:04:34,050

light sheet camera orientation and

96

00:04:37,550 --> 00:04:35,669

imaging properties as well as white

97

00:04:41,240 --> 00:04:37,560

sheet position and angle were measured

98

00:04:42,890 --> 00:04:41,250

to provide accurate calculations once a

99

00:04:44,990 --> 00:04:42,900

set of data for a specified test

100

00:04:46,460 --> 00:04:45,000

condition was constructed the 3d

101

00:04:48,950 --> 00:04:46,470

coordinate of any point in the flow

102

00:04:51,260 --> 00:04:48,960

field could be determined vortex core

103

00:04:52,760 --> 00:04:51,270

paths determined from image centroids as

104

00:04:55,010 --> 00:04:52,770

well as the approximate reattachment

105

00:04:58,790 --> 00:04:55,020

lines could be extracted and displayed

106

00:05:00,380 --> 00:04:58,800

in simultaneously the same sequence of

107

00:05:02,690 --> 00:05:00,390

operations was applied to the side

108

00:05:04,850 --> 00:05:02,700

camera image such that both camera data

109

00:05:12,550 --> 00:05:04,860

sets were combined into one interactive

110

00:05:16,820 --> 00:05:15,140

selected frames from videotapes for each

111

00:05:19,129 --> 00:05:16,830

flight were digitized on the data

112

00:05:22,730 --> 00:05:19,139

visualization and animation labs video

113

00:05:24,529 --> 00:05:22,740

image processing system the video image

114

00:05:26,179 --> 00:05:24,539

processing system is a combination of

115

00:05:28,070 --> 00:05:26,189

hardware and software designed to

116

00:05:30,200 --> 00:05:28,080

provide interactive capability for

117

00:05:33,320 --> 00:05:30,210

processing videotaped images of wind

118

00:05:35,200 --> 00:05:33,330

tunnel or in flight experiments the

119

00:05:37,760 --> 00:05:35,210

system controlled from a host computer

120

00:05:40,040 --> 00:05:37,770

consists of an image processing system

121

00:05:42,740 --> 00:05:40,050

video equipment and a real-time digital

122

00:05:44,480 --> 00:05:42,750

disc the software interface is a

123

00:05:46,820 --> 00:05:44,490

commercially available image processing

124

00:05:49,129 --> 00:05:46,830

software system the system is designed

125

00:05:52,670 --> 00:05:49,139

to accept common video formats including

126
00:05:55,369 --> 00:05:52,680
the s VHS and VHS formats used in this

127
00:05:58,129 --> 00:05:55,379
flight test the software allows VCR

128
00:05:59,990 --> 00:05:58,139
control from the computer station video

129
00:06:02,860 --> 00:06:00,000
footage is digitized and stored a

130
00:06:05,600 --> 00:06:02,870
digital disc at 30 frames per second

131
00:06:07,430 --> 00:06:05,610
once rendered to real time disk the

132
00:06:10,550 --> 00:06:07,440
images are slowed down during playback

133
00:06:12,080 --> 00:06:10,560
and examined in slow motion timecode

134
00:06:14,350 --> 00:06:12,090
information appearing in the lower left

135
00:06:16,879 --> 00:06:14,360
corner uniquely identifies each image

136
00:06:25,959 --> 00:06:16,889
selected images were stored on a disc

137
00:06:30,699 --> 00:06:28,629
with the use of extractor software the

138
00:06:32,649 --> 00:06:30,709

poor locations for a vortex system were

139

00:06:35,679 --> 00:06:32,659

determined by examining each printed

140

00:06:38,079 --> 00:06:35,689

image the show movie of this directory

141

00:06:39,699 --> 00:06:38,089

option enables an overall impression of

142

00:06:42,219 --> 00:06:39,709

flow over the wing at the test condition

143

00:06:45,359 --> 00:06:42,229

and allows the determination of how many

144

00:06:47,379 --> 00:06:45,369

vortices are present and the progression

145

00:06:49,779 --> 00:06:47,389

beginning with the first image to be

146

00:06:52,089 --> 00:06:49,789

examined invoked the defined region of

147

00:06:53,829 --> 00:06:52,099

interest for this image option and use

148

00:06:55,829 --> 00:06:53,839

the mouse to circumscribe the region

149

00:06:58,899 --> 00:06:55,839

where the core is thought to be located

150

00:07:01,359 --> 00:06:58,909

the horizontal and vertical pixel values

151

00:07:03,249 --> 00:07:01,369

for this core is saved however if other

152

00:07:05,499 --> 00:07:03,259

cores are present on this image they

153

00:07:08,589 --> 00:07:05,509

must also be determined and saved before

154

00:07:12,100 --> 00:07:08,599

proceeding the same steps are repeated

155

00:07:14,499 --> 00:07:12,110

for other images after all the images

156

00:07:16,929 --> 00:07:14,509

for the data set up in process the wave

157

00:07:18,819 --> 00:07:16,939

program is exited and the core pixel

158

00:07:22,179 --> 00:07:18,829

values up to four sets per image are

159

00:07:24,219 --> 00:07:22,189

moved to a permanent file to determine

160

00:07:28,509 --> 00:07:24,229

the reattachment points the extractor

161

00:07:30,189 --> 00:07:28,519

software is once again used the outer

162

00:07:31,689 --> 00:07:30,199

part of the vortex is projected

163

00:07:34,149 --> 00:07:31,699

vertically to the forward part of the

164

00:07:35,919 --> 00:07:34,159

light sheet footprint this is followed

165

00:07:39,279 --> 00:07:35,929

by a circumscription of a small region

166

00:07:41,079 --> 00:07:39,289

on the footprint with the mouse after

167

00:07:42,959 --> 00:07:41,089

the horizontal and vertical pixel values

168

00:07:45,159 --> 00:07:42,969

for the pointer found they are saved

169

00:07:46,929 --> 00:07:45,169

what other reattachment points are

170

00:07:49,439 --> 00:07:46,939

present on this image they must also be

171

00:07:52,029 --> 00:07:49,449

determined and saved before proceeding

172

00:07:54,219 --> 00:07:52,039

prior to saving all these pixel values

173

00:07:56,079 --> 00:07:54,229

consistency in the criterion used to

174

00:07:58,299 --> 00:07:56,089

determine reattachment points is checked

175

00:08:01,239 --> 00:07:58,309

these steps are repeated for the other

176

00:08:03,609 --> 00:08:01,249

images after all the images for the data

177

00:08:05,589 --> 00:08:03,619

set have been processed the wave program

178

00:08:07,509 --> 00:08:05,599

is exited and the reattachment point

179

00:08:15,690 --> 00:08:07,519

pixel values up to four sets per image

180

00:08:20,320 --> 00:08:18,460

to display vortex flow features is

181

00:08:21,940 --> 00:08:20,330

characterized by the vapor screen image

182

00:08:23,800 --> 00:08:21,950

in poor location with reattachment

183

00:08:26,470 --> 00:08:23,810

points in a three-dimensional mode a

184

00:08:28,660 --> 00:08:26,480

Silicon Graphics iris workstation and

185

00:08:32,080 --> 00:08:28,670

the flow analysis software toolkit

186

00:08:34,510 --> 00:08:32,090

called fast was utilized once logged

187

00:08:36,280 --> 00:08:34,520

onto the iris a remote login is done to

188

00:08:38,320 --> 00:08:36,290

a host computer containing the image

189

00:08:40,930 --> 00:08:38,330

files along with poor location and

190

00:08:42,970 --> 00:08:40,940

reattachment point trials with a fast

191

00:08:44,650 --> 00:08:42,980

script written for this purpose it is

192

00:08:46,420 --> 00:08:44,660

simple to obtain the vortex system

193

00:08:49,030 --> 00:08:46,430

features on a wing by keying in the

194

00:08:50,890 --> 00:08:49,040

corresponding points this generates the

195

00:08:52,540 --> 00:08:50,900

feature from both the top and side

196

00:08:54,370 --> 00:08:52,550

cameras in terms of the

197

00:08:56,290 --> 00:08:54,380

three-dimensional coordinates consistent

198

00:08:58,960 --> 00:08:56,300

with the aircraft and then displays them

199

00:09:01,000 --> 00:08:58,970

on the surface geometry by using the

200

00:09:02,710 --> 00:09:01,010

capabilities of fast the resulting

201
00:09:04,540 --> 00:09:02,720
three-dimensional representation would

202
00:09:13,960 --> 00:09:04,550
be moved until it resembles the NASA

203
00:09:18,999 --> 00:09:16,900
in 1985 the stationary light sheet was

204
00:09:21,069 --> 00:09:19,009
used to illuminate a fixed cross section

205
00:09:24,160 --> 00:09:21,079
of a flow field above the wing of the f1

206
00:09:26,379 --> 00:09:24,170
or 6 be a camera calibration was not

207
00:09:28,059 --> 00:09:26,389
performed at the time of his flight thus

208
00:09:30,699 --> 00:09:28,069
the photo prometric reconstruction

209
00:09:32,290 --> 00:09:30,709
technique could not be applied spatial

210
00:09:34,210 --> 00:09:32,300
information was obtained before the

211
00:09:36,400 --> 00:09:34,220
flights by placing a physical grid of

212
00:09:39,129 --> 00:09:36,410
regularly spaced 6 inch squares in

213
00:09:40,780 --> 00:09:39,139

refrain of the light sheet when the grid

214

00:09:43,030 --> 00:09:40,790

was photographed by the camera in its

215

00:09:45,189 --> 00:09:43,040

flight position a prospective distortion

216

00:09:47,290 --> 00:09:45,199

was introduced the distortion was

217

00:09:49,480 --> 00:09:47,300

corrected using a warping procedure to

218

00:09:52,629 --> 00:09:49,490

produce an image in which the gridlines

219

00:09:54,340 --> 00:09:52,639

were regularly spaced the warping

220

00:09:56,889 --> 00:09:54,350

technique was applied to selecting vapor

221

00:09:59,139 --> 00:09:56,899

screen images from 1985 and the

222

00:10:01,259 --> 00:09:59,149

resulting images were evenly distributed

223

00:10:04,420 --> 00:10:01,269

across the light sheet plane to

224

00:10:06,699 --> 00:10:04,430

reconstruct 3d coordinates when loaded

225

00:10:08,590 --> 00:10:06,709

into the fast program the vapour screen

226
00:10:11,259 --> 00:10:08,600
images produced by the stationary light

227
00:10:12,879 --> 00:10:11,269
sheet in 1985 could be correlated with

228
00:10:16,629 --> 00:10:12,889
those obtained from the rotating light

229
00:10:18,429 --> 00:10:16,639
sheet of 1991 the vortex core paths and

230
00:10:20,829 --> 00:10:18,439
reattachment lines extracted from the

231
00:10:29,020 --> 00:10:20,839
1991 flight data could be displayed

232
00:10:35,110 --> 00:10:31,510
with the enhancer software the vortex

233
00:10:37,210 --> 00:10:35,120
system details can be enhanced the code

234
00:10:39,700 --> 00:10:37,220
expects the user to key in the starting

235
00:10:41,380 --> 00:10:39,710
and ending white sheet angles as well as

236
00:10:44,620 --> 00:10:41,390
the filename containing the group of

237
00:10:46,420 --> 00:10:44,630
files to consider the code displays all

238
00:10:48,160 --> 00:10:46,430

the images in the group and asked

239

00:10:50,980 --> 00:10:48,170

whether or not a particular image is to

240

00:10:53,140 --> 00:10:50,990

be included for enhancement choosing the

241

00:10:56,620 --> 00:10:53,150

enhance this image option for the first

242

00:10:58,540 --> 00:10:56,630

image leads to yet another menu a three

243

00:11:00,520 --> 00:10:58,550

by three smoothing on each image is

244

00:11:02,740 --> 00:11:00,530

imposed a total of three times in

245

00:11:04,990 --> 00:11:02,750

combination with the continued

246

00:11:07,960 --> 00:11:05,000

enhancement to the image process option

247

00:11:09,970 --> 00:11:07,970

the contrast stretch option is used to

248

00:11:11,710 --> 00:11:09,980

spread the entire range of pseudo colors

249

00:11:15,250 --> 00:11:11,720

in such a way as to emphasize the

250

00:11:17,950 --> 00:11:15,260

existing gradation in this image the

251
00:11:21,780 --> 00:11:17,960
contour option allows selected colors to

252
00:11:24,760 --> 00:11:21,790
be set to black thereby forming contours

253
00:11:27,160 --> 00:11:24,770
finally the save enhanced flight image

254
00:11:29,350 --> 00:11:27,170
option is used which displays the image

255
00:11:37,670 --> 00:11:29,360
with an identification code and then

256
00:11:41,690 --> 00:11:39,740
the photogrammetric reconstruction

257
00:11:43,880 --> 00:11:41,700
technique which maps vapor images onto

258
00:11:46,070 --> 00:11:43,890
light sheet planes was extended to

259
00:11:49,519 --> 00:11:46,080
project imagery onto any arbitrary

260
00:11:51,320 --> 00:11:49,529
surface composed of polygons this

261
00:11:53,570 --> 00:11:51,330
extension was specifically used to

262
00:11:55,760 --> 00:11:53,580
project oil flow patterns videotaped by

263
00:11:58,639 --> 00:11:55,770

the top camera onto the political model

264

00:12:00,800 --> 00:11:58,649

of a wing surface vapor screen images

265

00:12:02,840 --> 00:12:00,810

core paths and reattachment lines

266

00:12:05,540 --> 00:12:02,850

extracted from the rotating light sheet

267

00:12:13,310 --> 00:12:05,550

but then be displayed simultaneously for

268

00:12:14,690 --> 00:12:13,320

a direct comparison this video

269

00:12:16,250 --> 00:12:14,700

supplement has been designed to

270

00:12:18,500 --> 00:12:16,260

demonstrate the computer graphics

271

00:12:21,350 --> 00:12:18,510

capabilities utilized in developing data

272

00:12:23,210 --> 00:12:21,360

which are presented in the report the

273

00:12:25,010 --> 00:12:23,220

viewers reminded that this supplement

274

00:12:27,380 --> 00:12:25,020

does not purport to present the complete

275

00:12:29,420 --> 00:12:27,390

set of various data types or the

276

00:12:31,510 --> 00:12:29,430

attendant analyses both of which are

277

00:12:33,829 --> 00:12:31,520

contained on the NASA technical paper

278

00:12:35,269 --> 00:12:33,839

therefore the view is referred to the