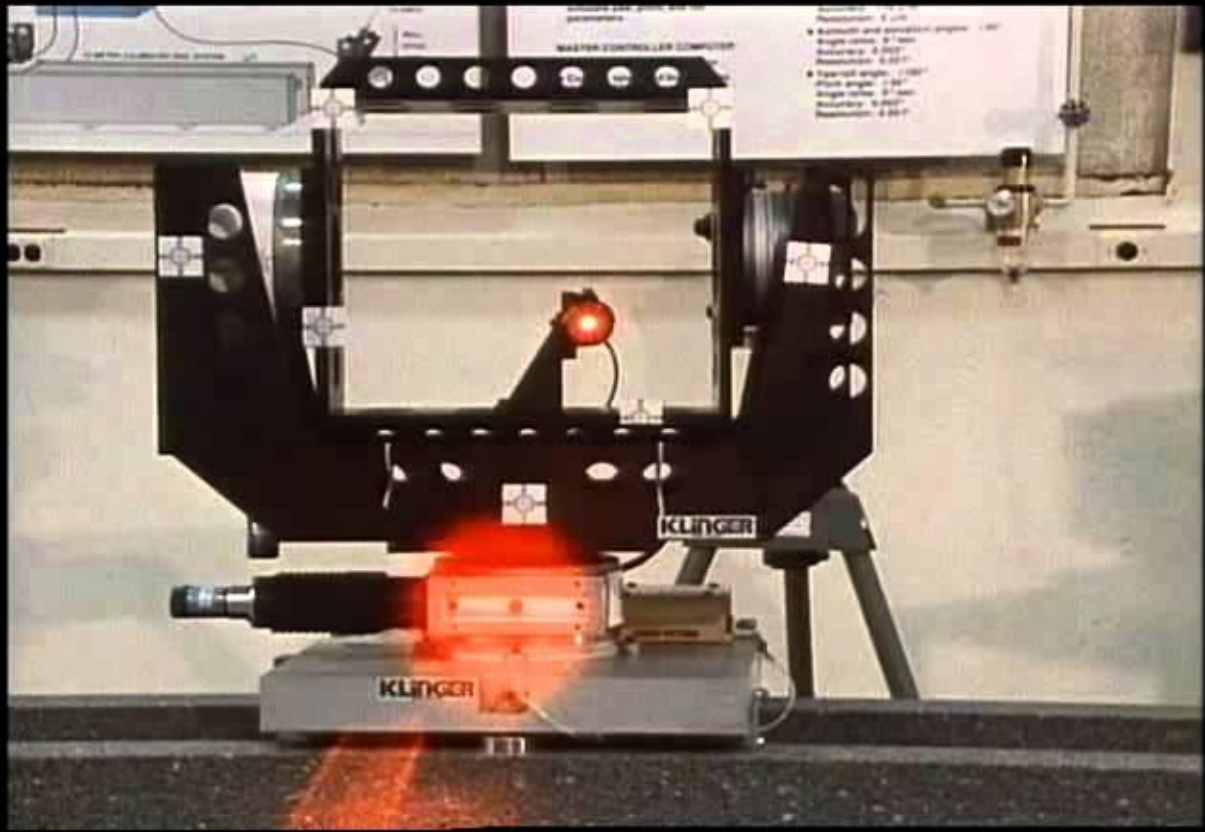
KLINGER
KLINGER

1
00:00:00,000 --> 00:00:27,910
foreign

2
00:00:31,189 --> 00:00:29,269
for years

3
00:00:35,510 --> 00:00:31,199
the dream of conquering the space

4
00:00:37,990 --> 00:00:35,520
frontier has continued to become reality

5
00:00:40,470 --> 00:00:38,000
an increased level of operations in this

6
00:00:45,590 --> 00:00:40,480
challenging environment will require

7
00:00:49,750 --> 00:00:47,190
to achieve this

8
00:00:52,229 --> 00:00:49,760
a safe rendezvous and docking mechanism

9
00:00:54,150 --> 00:00:52,239
is essential

10
00:00:56,869 --> 00:00:54,160
an accurate docking sensor would

11
00:00:59,750 --> 00:00:56,879
minimize plume impingement

12
00:01:02,869 --> 00:00:59,760
increase fuel efficiency

13
00:01:07,590 --> 00:01:02,879

simplify docking mechanisms

14
00:01:11,190 --> 00:01:09,109
more importantly

15
00:01:14,070 --> 00:01:11,200
the system would be capable of operating

16
00:01:16,390 --> 00:01:14,080
in a fully autonomous mode

17
00:01:20,469 --> 00:01:16,400
this would minimize the necessary crew

18
00:01:24,870 --> 00:01:22,550
various optical docking sensors have

19
00:01:27,830 --> 00:01:24,880
been proposed which provide information

20
00:01:31,830 --> 00:01:27,840
on range bearing angles

21
00:01:34,390 --> 00:01:31,840
attitude and their respective rates

22
00:01:37,670 --> 00:01:34,400
accuracies for these sensors are fairly

23
00:01:41,190 --> 00:01:39,190
as a result

24
00:01:43,510 --> 00:01:41,200
a system is being designed by the

25
00:01:46,149 --> 00:01:43,520
tracking and communications division at

26
00:01:50,710 --> 00:01:46,159
nasa's johnson space center to test the

27
00:01:55,190 --> 00:01:52,149
this system

28
00:01:57,270 --> 00:01:55,200
designated the six degree of freedom or

29
00:01:59,590 --> 00:01:57,280
six doff system

30
00:02:02,310 --> 00:01:59,600
provides six degrees of movement by

31
00:02:05,190 --> 00:02:02,320
using five rotational stages

32
00:02:06,230 --> 00:02:05,200
and one linear stage

33
00:02:07,670 --> 00:02:06,240
range

34
00:02:10,389 --> 00:02:07,680
bearing angles

35
00:02:12,949 --> 00:02:10,399
attitude and their respective rates are

36
00:02:15,830 --> 00:02:12,959
provided

37
00:02:17,830 --> 00:02:15,840
range is furnished by a granite rail 12

38
00:02:21,270 --> 00:02:17,840

meters in length with a carriage

39
00:02:23,589 --> 00:02:21,280
floating on three air bearings

40
00:02:27,430 --> 00:02:23,599
the maximum change in range travel

41
00:02:30,229 --> 00:02:27,440
distance is 10.5 meters while rates can

42
00:02:34,229 --> 00:02:30,239
vary from 5 millimeters per second to

43
00:02:39,190 --> 00:02:36,630
mounted inside the granite rail is a

44
00:02:41,350 --> 00:02:39,200
linear encoder with a resolution of 5

45
00:02:43,110 --> 00:02:41,360
microns

46
00:02:45,509 --> 00:02:43,120
the gratings on the encoder are

47
00:02:49,670 --> 00:02:45,519
photoelectrically scanned and counted to

48
00:02:57,830 --> 00:02:51,990
two rotational stages on top of the

49
00:02:57,840 --> 00:03:02,790
and elevation

50
00:03:08,550 --> 00:03:06,070
referred to as the sensor gimbal mount

51
00:03:11,910 --> 00:03:08,560
this entire assembly can safely support

52
00:03:14,390 --> 00:03:11,920
a sensor weighing up to 40 kilograms

53
00:03:16,630 --> 00:03:14,400
here a laser is mounted on the sensor

54
00:03:20,470 --> 00:03:16,640
gimbal mount to simulate a docking

55
00:03:25,750 --> 00:03:23,030
a separate movable granite table

56
00:03:28,470 --> 00:03:25,760
designated the target gimbal mount

57
00:03:32,550 --> 00:03:28,480
is offset from the granite rail

58
00:03:42,550 --> 00:03:32,560
three rotary stages provide yaw

59
00:03:42,560 --> 00:03:52,149
and pitch

60
00:03:56,550 --> 00:03:54,710
all five rotational stages contain

61
00:03:58,949 --> 00:03:56,560
rotary encoders that possess a

62
00:04:01,750 --> 00:03:58,959
resolution of one one thousandth of a

63
00:04:04,070 --> 00:04:01,760

degree

64
00:04:06,149 --> 00:04:04,080
a retro reflector assembly would be a

65
00:04:09,910 --> 00:04:06,159
typical target attached to the target

66
00:04:14,789 --> 00:04:12,710
a 19-inch rack houses the equipment

67
00:04:16,710 --> 00:04:14,799
necessary to operate the sixth off

68
00:04:18,629 --> 00:04:16,720
stages

69
00:04:21,590 --> 00:04:18,639
included is a computer containing the

70
00:04:25,670 --> 00:04:21,600
control software which drives the stages

71
00:04:30,390 --> 00:04:27,909
the six dof subsystems are also

72
00:04:32,629 --> 00:04:30,400
contained in this rack

73
00:04:36,790 --> 00:04:32,639
including a global positioning system

74
00:04:39,189 --> 00:04:36,800
time receiver and a rate meter

75
00:04:41,590 --> 00:04:39,199
these instruments provide time tagging

76
00:04:46,790 --> 00:04:41,600
and calculation of absolute and relative

77
00:04:50,950 --> 00:04:48,469
okay

78
00:04:53,430 --> 00:04:50,960
operation of the sixth system is based

79
00:04:55,350 --> 00:04:53,440
on knowing the initial coordinates of 14

80
00:04:57,510 --> 00:04:55,360
reference points on the two gimbal

81
00:04:59,909 --> 00:04:57,520
mounts and commanding the stages to move

82
00:05:06,550 --> 00:04:59,919
to a desired range and attitude at a

83
00:05:10,469 --> 00:05:08,629
in order for all position and rate

84
00:05:11,430 --> 00:05:10,479
measurements to be relative to each

85
00:05:14,950 --> 00:05:11,440
other

86
00:05:17,590 --> 00:05:14,960
a common coordinate system was defined

87
00:05:20,150 --> 00:05:17,600
a digital metrology system is used to

88
00:05:23,189 --> 00:05:20,160

shoot individual targets and calculate

89
00:05:25,270 --> 00:05:23,199
position coordinates

90
00:05:29,270 --> 00:05:25,280
these coordinates are then entered into

91
00:05:36,629 --> 00:05:32,629
the stages are commanded to move

92
00:05:38,790 --> 00:05:36,639
the laser spot searches for the target

93
00:05:41,350 --> 00:05:38,800
the proximity of the laser spot to the

94
00:05:46,230 --> 00:05:41,360
desired target determines the accuracy

95
00:05:51,029 --> 00:05:48,790
in a typical testing scenario

96
00:05:53,350 --> 00:05:51,039
static and dynamic accuracies will be

97
00:05:55,590 --> 00:05:53,360
tested on a candidate optical docking

98
00:05:57,590 --> 00:05:55,600
sensor

99
00:05:59,909 --> 00:05:57,600
position information taken from the

100
00:06:01,830 --> 00:05:59,919
sensor will be compared to the true six

101
00:06:04,070 --> 00:06:01,840
dot position

102
00:06:06,150 --> 00:06:04,080
dynamic information is provided by

103
00:06:08,629 --> 00:06:06,160
comparing the tracking capability of the

104
00:06:12,870 --> 00:06:08,639
docking sensor to that of the more

105
00:06:16,150 --> 00:06:15,189
future enhancements of the six dof

106
00:06:18,550 --> 00:06:16,160
system

107
00:06:21,510 --> 00:06:18,560
include a proposed expansion into an

108
00:06:23,110 --> 00:06:21,520
autonomous rendezvous and docking test

109
00:06:25,990 --> 00:06:23,120
facility

110
00:06:29,590 --> 00:06:26,000
here docking scenarios will be set up to

111
00:06:31,510 --> 00:06:29,600
gain knowledge on docking sensors

112
00:06:33,830 --> 00:06:31,520
this will enable development of an

113
00:06:35,670 --> 00:06:33,840

optimum docking sensor that could be

114
00:06:44,070 --> 00:06:35,680
used in a multitude of docking

115
00:06:48,550 --> 00:06:46,550
a potential application of the six dof

116
00:06:51,990 --> 00:06:48,560
system would support the shuttle and

117
00:06:54,230 --> 00:06:52,000
space station docking simulator

118
00:06:56,150 --> 00:06:54,240
currently astronauts practice docking

119
00:07:00,950 --> 00:06:56,160
the shuttle to the space station by

120
00:07:05,510 --> 00:07:02,870
if this system was connected to the

121
00:07:06,950 --> 00:07:05,520
simulator it could move using the

122
00:07:09,189 --> 00:07:06,960
relative range

123
00:07:12,870 --> 00:07:09,199
bearing angles and attitude as

124
00:07:14,629 --> 00:07:12,880
calculated by the six dof system

125
00:07:20,150 --> 00:07:14,639
this would enable the simulator to

126
00:07:28,469 --> 00:07:23,270
from enhancing astronaut training

127
00:07:33,990 --> 00:07:31,909
to aiding orbital assembly

128
00:07:36,710 --> 00:07:34,000
the accuracy of the six degree of

129
00:07:37,990 --> 00:07:36,720
freedom system will provide an important

130
00:07:40,390 --> 00:07:38,000
service