

A man with short grey hair, wearing a dark t-shirt, stands in a workshop. He is looking towards the camera with a slightly questioning expression. The workshop is filled with tools, including a drill press, a table saw, and various hand tools on a pegboard. A large, bright yellow text overlay 'GIMBAL?' is superimposed over the center of the image. The background shows white cabinets and a door.

GIMBAL?

A close-up view of a dark metal plate with technical markings. The markings include 'NAR Z 2.0', 'OPR', 'LST 88 88 D/R', '25010', and 'ADV-M4 OK, 240 M 0.58'. A large, bright yellow text overlay 'GIMBAL!' is superimposed over the bottom half of the image. The background is a blurred workshop setting.

GIMBAL!

1
00:00:06,769 --> 00:00:01,910
so there's all the questions about the

2
00:00:09,049 --> 00:00:06,779
gimbal video and how the craft appears

3
00:00:12,589 --> 00:00:09,059
to be rotating and what it is it is

4
00:00:15,919 --> 00:00:12,599
actually appears to be a flare some kind

5
00:00:17,840 --> 00:00:15,929
of bloomer in the IR sensor created by

6
00:00:20,540 --> 00:00:17,850
they've been slightly out of focus and

7
00:00:22,820 --> 00:00:20,550
by the shape of the optics and it's the

8
00:00:24,830 --> 00:00:22,830
glare that's rotating it's not actually

9
00:00:27,740 --> 00:00:24,840
a craft itself it's probably just a

10
00:00:29,839 --> 00:00:27,750
business jet display rotating but how

11
00:00:32,089 --> 00:00:29,849
does that happen I've kind of explained

12
00:00:34,250 --> 00:00:32,099
it before but it's it's a difficult

13
00:00:36,049 --> 00:00:34,260

thing to actually visualize you don't

14

00:00:39,950 --> 00:00:36,059

think about how the camera is mounted

15

00:00:41,900 --> 00:00:39,960

now this is a similar kind of camera

16

00:00:44,299 --> 00:00:41,910

configuration now a lot of times you'll

17

00:00:46,850 --> 00:00:44,309

see cameras mounted like this especially

18

00:00:48,950 --> 00:00:46,860

underneath helicopters the amount of so

19

00:00:52,520 --> 00:00:48,960

that they can pair like this and they

20

00:00:55,010 --> 00:00:52,530

can rotate around like this which means

21

00:00:56,180 --> 00:00:55,020

that if you want subtract something you

22

00:00:58,099 --> 00:00:56,190

just point down at the angle that

23

00:00:59,720 --> 00:00:58,109

something is moving at and then you just

24

00:01:01,099 --> 00:00:59,730

rotate the camera around and it will

25

00:01:03,500 --> 00:01:01,109

track it it's quite quite

26

00:01:05,690 --> 00:01:03,510

straightforward but with the act clear

27

00:01:08,810 --> 00:01:05,700

is that the type of camera that was

28

00:01:11,270 --> 00:01:08,820

being used in the gimbal video two-carat

29

00:01:13,789 --> 00:01:11,280

mounted like this it's melted forward

30

00:01:15,200 --> 00:01:13,799

it's facing a forward direction which

31

00:01:17,749 --> 00:01:15,210

means you can tell Nero it takes in two

32

00:01:20,600 --> 00:01:17,759

ways it rotates along a horizontal axis

33

00:01:22,969 --> 00:01:20,610

and it can rotate up and down which

34

00:01:25,370 --> 00:01:22,979

means the time from left to right texta

35

00:01:28,429 --> 00:01:25,380

quite difficult when something is

36

00:01:30,380 --> 00:01:28,439

pointed down how do you pan to go to the

37

00:01:33,800 --> 00:01:30,390

side you're actually have to tilt the

38

00:01:36,710 --> 00:01:33,810

camera up and down and that means that

39

00:01:38,840 --> 00:01:36,720

the image is going to rotate so if the

40

00:01:40,670 --> 00:01:38,850

image is rotating as something you don't

41

00:01:43,069 --> 00:01:40,680

want so what they do is inside the

42

00:01:45,289 --> 00:01:43,079

camera system Thursday think all the D

43

00:01:47,420 --> 00:01:45,299

rotating mechanism which actor takes

44

00:01:49,219 --> 00:01:47,430

that rotation corrects it and puts it

45

00:01:51,230 --> 00:01:49,229

the right way up but the camera is

46

00:01:53,569 --> 00:01:51,240

rotating which means that the glare and

47

00:01:55,700 --> 00:01:53,579

rotate this is perhaps a bit easier to

48

00:01:58,520 --> 00:01:55,710

visualize if you look at something a

49

00:02:01,399 --> 00:01:58,530

little little larger here I've done

50

00:02:05,060 --> 00:02:01,409

something that's got a similar degrees

51
00:02:05,610 --> 00:02:05,070
of freedom it's a stick with a hinge

52
00:02:08,070 --> 00:02:05,620
base

53
00:02:13,310 --> 00:02:08,080
like investigate inside these two

54
00:02:15,990 --> 00:02:13,320
funnels that cut here I can rotate it

55
00:02:17,280 --> 00:02:16,000
around the axis this is the same

56
00:02:19,380 --> 00:02:17,290
essentially as being on the underneath

57
00:02:21,630 --> 00:02:19,390
of the jet so this is rotating around

58
00:02:23,250 --> 00:02:21,640
the forward axis and it can rotate up

59
00:02:25,110 --> 00:02:23,260
and down which goes to your left and

60
00:02:26,880 --> 00:02:25,120
right if you rotate around that way so

61
00:02:28,800 --> 00:02:26,890
you found subtract something like the

62
00:02:31,890 --> 00:02:28,810
edge of this table since that something

63
00:02:32,400 --> 00:02:31,900

is running along here or flying a line

64

00:02:36,390 --> 00:02:32,410

here

65

00:02:39,060 --> 00:02:36,400

I want to distract that motion then if

66

00:02:39,960 --> 00:02:39,070

it's stop pointing over here and move to

67

00:02:43,980 --> 00:02:39,970

here you'll see this

68

00:02:46,710 --> 00:02:43,990

everything has to actually rotate this

69

00:02:49,560 --> 00:02:46,720

will be even clearer if I add on a stick

70

00:02:52,610 --> 00:02:49,570

so we can actually see the actual line

71

00:02:58,100 --> 00:02:52,620

of sight of the camera I'm just going to

72

00:03:01,800 --> 00:03:00,270

ok so now we've got the same symbols

73

00:03:03,420 --> 00:03:01,810

before but now we have this stick

74

00:03:04,830 --> 00:03:03,430

representing the line of sight of the

75

00:03:07,009 --> 00:03:04,840

cameras this is what the camera is

76
00:03:09,479 --> 00:03:07,019
looking at and that's just where the up

77
00:03:11,070 --> 00:03:09,489
direction is on the camera this will

78
00:03:13,619 --> 00:03:11,080
tell you that the horizon is going to be

79
00:03:15,559 --> 00:03:13,629
perpendicular to this up direction so if

80
00:03:18,210 --> 00:03:15,569
we subtract something over to the side

81
00:03:19,860 --> 00:03:18,220
you'll see that the cameras up Direction

82
00:03:22,050 --> 00:03:19,870
now has to move quite a bit which means

83
00:03:23,789 --> 00:03:22,060
that the camera itself has rotated which

84
00:03:25,380 --> 00:03:23,799
means that internally it has to then use

85
00:03:27,660 --> 00:03:25,390
the D rotation to get rid of that

86
00:03:30,270 --> 00:03:27,670
rotation so if we're tracking something

87
00:03:32,670 --> 00:03:30,280
from left to right you'll see it'll move

88
00:03:34,220 --> 00:03:32,680

across and then it will start tilting

89

00:03:38,339 --> 00:03:34,230

the other way so you get this kind of

90

00:03:42,869 --> 00:03:38,349

swayed actions adjust to use this as a

91

00:03:44,369 --> 00:03:42,879

way of tracking the object now in the

92

00:03:46,770 --> 00:03:44,379

gimbal video it's actually only pointing

93

00:03:48,960 --> 00:03:46,780

down a fairly small amount around 2

94

00:03:50,910 --> 00:03:48,970

degrees so that that changed things a

95

00:03:55,250 --> 00:03:50,920

little bit let me just flip this upside

96

00:03:57,300 --> 00:03:55,260

down and I will see how that affects it

97

00:03:59,369 --> 00:03:57,310

so here we've got a more shallow angle

98

00:04:00,869 --> 00:03:59,379

you think you might make the problem bit

99

00:04:03,720 --> 00:04:00,879

simpler what actually makes it worse you

100

00:04:05,520 --> 00:04:03,730

have to rotate a lot almost instantly

101
00:04:07,620 --> 00:04:05,530
with a small motion but once you've gone

102
00:04:10,140 --> 00:04:07,630
past that angle the amount of rotation

103
00:04:11,520 --> 00:04:10,150
that's needed isn't that much which

104
00:04:13,140 --> 00:04:11,530
means they knew when you get close to

105
00:04:14,280 --> 00:04:13,150
the center if the angle is very shallow

106
00:04:16,229 --> 00:04:14,290
and it's actually going to be a bit more

107
00:04:18,810 --> 00:04:16,239
child and this then you're going to get

108
00:04:21,029 --> 00:04:18,820
a more certain rotation as you cross the

109
00:04:23,909 --> 00:04:21,039
zero point the straight ahead point you

110
00:04:25,620 --> 00:04:23,919
see when it's here almost instantly with

111
00:04:27,540 --> 00:04:25,630
a small turn to the side of a few

112
00:04:31,080 --> 00:04:27,550
degrees from Auriemma nearly 45 degrees

113
00:04:32,550 --> 00:04:31,090

when it's tracking over here at a

114

00:04:33,679 --> 00:04:32,560

shallower angle it actually doesn't

115

00:04:35,509 --> 00:04:33,689

rotate frame

116

00:04:38,089 --> 00:04:35,519

something that we see in the gimbal

117

00:04:40,669 --> 00:04:38,099

video we see when it starts out it's a

118

00:04:42,379 --> 00:04:40,679

quite quite a large angle and track left

119

00:04:44,539 --> 00:04:42,389

to right this very little if any visible

120

00:04:46,279 --> 00:04:44,549

rotation when it gets the middle though

121

00:04:48,259 --> 00:04:46,289

it has to do this large Corrections

122

00:04:49,609 --> 00:04:48,269

because when you get to go the other

123

00:04:51,619 --> 00:04:49,619

direction we need to flip all the way

124

00:04:53,899 --> 00:04:51,629

over so that you can see from here to

125

00:04:57,439 --> 00:04:53,909

here that's about a 90 degree correction

126
00:05:00,319 --> 00:04:57,449
now the this isn't the only mechanism

127
00:05:03,429 --> 00:05:00,329
that the camera has for adjusting the

128
00:05:06,829 --> 00:05:03,439
rotation it also has some internal

129
00:05:09,559 --> 00:05:06,839
finer-grained stabilizers gimbal

130
00:05:11,209 --> 00:05:09,569
mechanism mechanisms inside so that will

131
00:05:12,499 --> 00:05:11,219
actually correct with a very small

132
00:05:15,259 --> 00:05:12,509
amount when you're going to land right

133
00:05:18,829 --> 00:05:15,269
over here but when you get to over here

134
00:05:20,149 --> 00:05:18,839
in the middle near a 0 0 degrees you

135
00:05:22,129 --> 00:05:20,159
need to do a much bigger correction

136
00:05:24,379 --> 00:05:22,139
which is where we see this large sudden

137
00:05:25,909 --> 00:05:24,389
turn and then another turn because it

138
00:05:30,799 --> 00:05:25,919

needs to go and start to obtain the

139

00:05:32,749 --> 00:05:30,809

other way so a big point about the

140

00:05:36,350 --> 00:05:32,759

gimbal video is that it's called the

141

00:05:38,449 --> 00:05:36,360

gimbal video and I think the reason it's

142

00:05:41,029 --> 00:05:38,459

called the gimbal video is that it's

143

00:05:45,469 --> 00:05:41,039

demonstrating essentially artifacts of a

144

00:05:47,829 --> 00:05:45,479

gimbal camera system this is they give

145

00:05:50,389 --> 00:05:47,839

abort camera systems again will dismiss

146

00:05:52,909 --> 00:05:50,399

rotations rotating mechanisms within

147

00:05:54,229 --> 00:05:52,919

other rotating mechanisms skimble this

148

00:05:57,619 --> 00:05:54,239

is essentially the same thing is with

149

00:05:59,389 --> 00:05:57,629

two axis of rotation this what we see

150

00:06:02,319 --> 00:05:59,399

here is actually something called gimbal

151

00:06:05,899 --> 00:06:02,329

lock which is a well known problem with

152

00:06:08,269 --> 00:06:05,909

limited degrees of freedom of camera

153

00:06:09,919 --> 00:06:08,279

system and this is something that

154

00:06:12,709 --> 00:06:09,929

obviously the Navy will be aware of

155

00:06:14,329 --> 00:06:12,719

perhaps they just call it this this

156

00:06:16,999 --> 00:06:14,339

video gimbal because it's the video

157

00:06:19,040 --> 00:06:17,009

being used in training perhaps the name

158

00:06:21,290 --> 00:06:19,050

itself is a clue to exactly what's going

159

00:06:25,819 --> 00:06:21,300

on you wonder why no and sort of this