1
00:00:02,416 --> 00:00:05,616
>> Pat Ryan: The Expedition
36 Crew is getting set

2
00:00:05,616 --> 00:00:09,256
to execute the first
space-based test of the system

3
00:00:09,256 --> 00:00:13,486
to permit control of a rover
on the ground by a crew member

4
00:00:13,486 --> 00:00:15,566
on board an orbiting
space craft.

5
00:00:15,846 --> 00:00:18,536
In this case today it will be
Flight Engineer Chris Cassidy

6
00:00:18,796 --> 00:00:21,596
controlling the activity
of a rover called K10,

7
00:00:21,596 --> 00:00:24,126
that you see here
which is located

8
00:00:24,126 --> 00:00:27,536
at NASA's Ames Research Center
in Moffett Field, California.

9
00:00:28,186 --> 00:00:30,646
Someday though, it might
be an astronaut who's

10
00:00:30,646 --> 00:00:33,716
at the L2 Lagrange Point
running a robot on the moon.

11
00:00:33,846 --> 00:00:38,436
The investigation called Surface
Telerobotics aims to find

12
00:00:38,436 --> 00:00:40,136
out how effectively a person

13
00:00:40,136 --> 00:00:42,666
on orbit can operate
a robot on the ground.

14
00:00:43,186 --> 00:00:47,116
Earlier I spoke with the Payload
Developer Maria Bualat at Ames

15
00:00:47,386 --> 00:00:49,676
about today's operation
and the background

16
00:00:49,676 --> 00:00:50,586
of this investigation.

17
00:00:50,706 --> 00:00:52,906
Well, let's start
at the beginning.

18
00:00:53,096 --> 00:00:54,926
Where did this idea come from?

19
00:00:54,976 --> 00:00:58,566
Tell me why we think it would
be a good idea for an astronaut

20
00:00:58,566 --> 00:01:02,446
in space to be able to control
a robot down on a planet

21
00:01:02,446 --> 00:01:03,976
or a moon or an asteroid?

22
00:01:05,016 --> 00:01:06,606
>> Maria Bualat: Well,
I'm not sure exactly

23
00:01:06,606 --> 00:01:08,166
where the original
idea comes from

24
00:01:08,166 --> 00:01:10,086
but we've been working a lot

25
00:01:10,086 --> 00:01:13,156
on the human exploration
architectures, looking at ways

26
00:01:13,156 --> 00:01:17,196
that robotics, what technologies
are needed to enable those

27
00:01:17,806 --> 00:01:21,386
and one of the hardest parts
of any planetary mission is

28
00:01:21,386 --> 00:01:26,296
to safely land on the
surface and a robot

29
00:01:26,296 --> 00:01:29,416
on the surface controlled by
a crew, say in an orbiting

30
00:01:29,416 --> 00:01:32,406
or approaching vehicle
can get a lot of the sort

31
00:01:32,406 --> 00:01:35,596
of precursor exploration
work done.

32
00:01:35,966 --> 00:01:37,496
A robot can be used,
for example,

33
00:01:37,496 --> 00:01:40,526
to prepare a landing
site so they could scout

34
00:01:40,526 --> 00:01:43,566
for a clear area, make
sure the ground is firm

35
00:01:43,946 --> 00:01:46,156
or even perhaps build
a landing strip.

36
00:01:46,796 --> 00:01:48,396
>> Pat Ryan: But a robot
couldn't do that all

37
00:01:48,396 --> 00:01:50,016
on preprogrammed instructions.

38
00:01:50,016 --> 00:01:51,096
It would need guidance.

39
00:01:51,266 --> 00:01:51,736
>> Maria Bualat: Right.

40
00:01:52,046 --> 00:01:52,206
Yes.

41
00:01:52,466 --> 00:01:54,456
>> Pat Ryan: Now most people
are familiar with the idea

42
00:01:54,456 --> 00:01:56,296
of a remote control
of a machine.

43
00:01:56,296 --> 00:01:59,106
I mean kids have remote
control planes and cars

44
00:01:59,546 --> 00:02:03,506
but what are the problems that
you're facing in this situation?

45
00:02:03,506 --> 00:02:05,576
What makes it hard for
an astronaut in space

46
00:02:05,736 --> 00:02:08,376
to control the rover
on the ground?

47
00:02:08,946 --> 00:02:11,996
>> Well first off there's
a communications delay

48
00:02:12,046 --> 00:02:15,716
between say, the station
and rover on the ground.

49
00:02:15,716 --> 00:02:19,326
In the case of Space Station
and here on earth it's a second

50
00:02:19,326 --> 00:02:23,156
or two and it just makes it
very difficult to joy stick.

51
00:02:23,156 --> 00:02:26,716
That delay just adds to
the amount of concentration

52
00:02:26,716 --> 00:02:28,366
that you need in
order to control it.

53
00:02:28,796 --> 00:02:31,166
So we use something
called supervisory control.

54
00:02:31,576 --> 00:02:33,066
So our robot's pretty smart.

55
00:02:33,066 --> 00:02:36,296
It can perform tasks,
it can keep itself safe

56
00:02:36,296 --> 00:02:38,456
and then the astronaut can take

57
00:02:38,456 --> 00:02:41,236
over if the rover
runs into any trouble.

58
00:02:41,236 --> 00:02:43,816
So it doesn't quite know
how to get around something

59
00:02:43,816 --> 00:02:46,836
or it isn't collecting
the correct data.

60
00:02:46,836 --> 00:02:49,866
So we have the crew member
monitoring what the robot's

61
00:02:49,866 --> 00:02:53,056
doing and that's a little
less of a direct control

62
00:02:53,056 --> 00:02:56,096
and so the delay
doesn't really interfere

63

00:02:56,096 --> 00:02:57,246
with that type of control.

64
00:02:57,736 --> 00:02:59,996
Another factor is the
space environment.

65
00:03:00,056 --> 00:03:01,786
So for example the
weightlessness,

66
00:03:01,786 --> 00:03:03,476
the radiation exposure,

67
00:03:03,476 --> 00:03:06,686
stress factors they can
affect human performance

68
00:03:06,686 --> 00:03:09,356
and make it hard to understand
the state of the robot.

69
00:03:09,906 --> 00:03:11,766
So our user interface
is designed

70
00:03:11,766 --> 00:03:14,546
to make the rover state
as clear as possible.

71
00:03:15,366 --> 00:03:16,746
>> Pat Ryan: The crew member,

72
00:03:16,746 --> 00:03:18,126
what kind of feedback
do they have?

73
00:03:18,126 --> 00:03:22,176
Is it just visual or does
the robot talk to them?

74
00:03:22,326 --> 00:03:24,176
>> Maria Bualat: Yes the
robot sends telemetry

75
00:03:24,176 --> 00:03:27,896
so it sends back information
about its position,

76
00:03:28,196 --> 00:03:30,576
about its different sub-systems.

77
00:03:30,576 --> 00:03:33,106
So for example what
the battery level is,

78
00:03:33,536 --> 00:03:38,256
how the instruments are
working, how it's pointed

79
00:03:38,596 --> 00:03:43,596
and also imagery, so the rover
uses stereo cameras in the front

80
00:03:43,746 --> 00:03:47,636
that give it information about
obstacles that are in front.

81
00:03:47,636 --> 00:03:49,146
And so we can use that imagery

82
00:03:49,146 --> 00:03:51,266
to let the crew see what
the rover is seeing.

83
00:03:51,686 --> 00:03:54,686
We also generate
virtual terrain.

84

00:03:54,756 --> 00:03:55,776
So we show the robot

85
00:03:55,776 --> 00:04:00,236
in a virtual environment that's
the train data has created using

86
00:04:00,236 --> 00:04:03,846
those stereo cameras and
also a LiDAR uses a laser

87
00:04:04,326 --> 00:04:07,186
to understand the three
dimensional terrain

88
00:04:07,186 --> 00:04:08,096
around the robot.

89
00:04:08,846 --> 00:04:10,436
>> Pat Ryan: Is this interaction

90
00:04:10,436 --> 00:04:11,916
between them pretty
well understood?

91
00:04:11,916 --> 00:04:14,826
Are you expecting to learn
something in this test

92
00:04:14,826 --> 00:04:16,216
that will let you refine it?

93
00:04:16,796 --> 00:04:19,496
>> Maria Bualat: We want to see
how a person in weightlessness

94
00:04:19,496 --> 00:04:21,776
and space reacts to this system.

95

00:04:22,006 --> 00:04:24,446
We've done a lot of work
with it on the ground

96
00:04:24,446 --> 00:04:28,356
but we've never done any
kind of testing in space.

97
00:04:28,716 --> 00:04:29,046
>> Pat Ryan: It sounds

98
00:04:29,046 --> 00:04:31,426
like you're testing
Chris Cassidy more

99
00:04:31,426 --> 00:04:32,506
than you're testing your rover.

100
00:04:32,636 --> 00:04:33,746
>> Maria Bualat: Not so much,

101
00:04:33,746 --> 00:04:36,426
I mean we will be
asking him questions.

102
00:04:36,426 --> 00:04:41,416
We'll say you know something
like is the robot able

103
00:04:41,416 --> 00:04:42,476
to drive forward one meter?

104
00:04:42,476 --> 00:04:43,976
Will it encounter an obstacle?

105
00:04:43,976 --> 00:04:45,056
What's its battery level?

106
00:04:45,056 --> 00:04:46,306

And we're just trying
to understand

107
00:04:46,616 --> 00:04:51,486
if he can get a good situational
awareness from our interface.

108
00:04:51,996 --> 00:04:55,676
So in a way we are testing him
but it's to give him an insight

109
00:04:55,676 --> 00:04:58,026
into how well our
interfaces work.

110
00:04:58,646 --> 00:05:02,486
>> Pat Ryan: In the case of this
test is there a planned sequence

111
00:05:02,486 --> 00:05:06,266
of events or is he just going
to give it random commands?

112
00:05:06,626 --> 00:05:07,706
>> Maria Bualat: We have a set

113
00:05:07,706 --> 00:05:09,636
of pre-planned sequences
for the robot.

114
00:05:09,666 --> 00:05:12,176
So the robot has its mission.

115
00:05:12,176 --> 00:05:16,136
We are going to simulate
deploying a radio telescope

116
00:05:16,136 --> 00:05:20,516
on the far side of the
moon and so the idea is

117
00:05:20,516 --> 00:05:25,156
that we'll have had orbital data
of the area we're interested in

118
00:05:25,446 --> 00:05:29,926
and so ground teams will have
created plans for the robot

119
00:05:29,926 --> 00:05:34,836
and the ideas that when Chris
sends the command to the robot

120
00:05:34,836 --> 00:05:37,106
and starts it executing
he'll just make sure

121
00:05:37,106 --> 00:05:40,606
that it's not encountering
anything that it can't handle.

122
00:05:40,846 --> 00:05:43,036
>> Pat Ryan: How
does he control it?

123
00:05:43,036 --> 00:05:46,576
Does he give it voice
commands or joy sticks

124
00:05:46,576 --> 00:05:47,506
or something like that?

125
00:05:47,666 --> 00:05:48,576
>> Maria Bualat:
No we are using,

126
00:05:48,576 --> 00:05:50,246
it's a graphical user interface.

127

00:05:50,476 --> 00:05:54,216
So he'll see, as I mentioned,
live images of the rover cameras

128
00:05:54,436 --> 00:05:58,466
as well as, there's a couple of
3-D virtual views of the robot.

129
00:05:58,916 --> 00:06:01,876
The robot has several
3-D sensors.

130
00:06:01,916 --> 00:06:04,776
So I mentioned the stereo
cameras and the LiDAR

131
00:06:05,256 --> 00:06:07,306
and then our system
uses that information

132
00:06:07,306 --> 00:06:11,236
to create 3-D virtual terrains
and then we have a model

133
00:06:11,236 --> 00:06:15,036
of the robot in that terrain
and that will display to Chris

134
00:06:15,736 --> 00:06:18,696
where the obstacles
are and he can use it

135
00:06:18,696 --> 00:06:20,256
to visualize what
the robot is doing.

136
00:06:20,966 --> 00:06:24,226
>> Pat Ryan: And he sends
the commands in what way?

137

00:06:24,516 --> 00:06:27,966
>> Maria Bualat: Basically
buttons, button presses.

138
00:06:27,966 --> 00:06:31,246
There's some preset commands.

139
00:06:31,396 --> 00:06:35,576
So for example, drive one meter
forward, rotate 15 degrees

140
00:06:35,576 --> 00:06:38,136
to the right, take
another panorama,

141
00:06:38,536 --> 00:06:42,336
so fairly simple full commands.

142
00:06:42,336 --> 00:06:45,946
>> Pat Ryan: And today's task
is quite lengthy in fact, right?

143
00:06:46,186 --> 00:06:46,726
>> Maria Bualat: Yes.

144
00:06:46,896 --> 00:06:49,026
We are, I believe we have a two

145
00:06:49,026 --> 00:06:51,316
and a half hour block
for operations.

146
00:06:51,476 --> 00:06:53,346
Before that we will be doing
a little bit of training

147
00:06:53,346 --> 00:06:54,676
on the user interface.

148

00:06:55,536 --> 00:06:57,906
>> Pat Ryan: At the end
of the day what is it

149
00:06:57,966 --> 00:06:58,926
that you hope to learn?

150
00:06:58,926 --> 00:07:01,116
What's going to be the next
step in this development?

151
00:07:01,546 --> 00:07:03,446
>> Maria Bualat: Well we
have two more crew sessions

152
00:07:03,446 --> 00:07:07,136
after this through the
summer, so roughly one a month.

153
00:07:07,136 --> 00:07:09,056
So we'll continue testing,

154
00:07:09,056 --> 00:07:11,636
continue collecting
data on the systems.

155
00:07:12,166 --> 00:07:13,456
We're not just going to look

156
00:07:13,456 --> 00:07:19,646
at how well the crew member can
control the robot but also some

157
00:07:19,646 --> 00:07:24,136
of our COMM systems, what
sorts of delays we're seeing.

158
00:07:24,216 --> 00:07:26,516
So we're also looking at
some other technologies.

159
00:07:26,986 --> 00:07:30,546
And then after that we're going
to look at, analyze that data,

160
00:07:30,616 --> 00:07:34,496
see how well our systems work,
where we can improve and also

161
00:07:34,496 --> 00:07:36,656
where are the gaps in
current technologies?

162
00:07:36,656 --> 00:07:39,466
So in other words, what new
technologies do we need?

163
00:07:39,466 --> 00:07:42,366
>> Pat Ryan: It sounds
like it will be fun

164
00:07:42,366 --> 00:07:43,436
and interesting to watch.

165
00:07:44,506 --> 00:07:45,126
>> Maria Bualat: It should be.

166
00:07:45,126 --> 00:07:48,016
Robots are usually fun to watch
since they're running around

167
00:07:48,656 --> 00:07:51,416
and a lot of people
tend to relate to them.

168
00:07:52,296 --> 00:07:53,526
>> Pat Ryan: Maria,

169
00:07:53,526 --> 00:07:55,876

really appreciate your taking
the time for the updating.

170
00:07:55,876 --> 00:07:56,806
Good luck with the tests.

171
00:07:56,916 --> 00:07:57,636
>> Maria Bualat:
Thank you very much.

172
00:07:57,896 --> 00:08:00,006
>> Pat Ryan: Maria Bualat
is the Payload Developer

173
00:08:00,006 --> 00:08:01,496
and Project Technical Lead

174
00:08:01,706 --> 00:08:03,916
for the Surface Telerobotics
Investigation