1
00:00:03,470 --> 00:00:02,149
NASA's jet propulsion laboratory

2
00:00:06,470 --> 00:00:03,480
presents

3
00:00:08,509 --> 00:00:06,480
the Von Carmen lecture a series of Talks

4
00:00:11,270 --> 00:00:08,519
by scientists and Engineers who are

5
00:00:13,310 --> 00:00:11,280
exploring our planet our solar system

6
00:00:20,450 --> 00:00:13,320
and all that lies Beyond

7
00:00:22,790 --> 00:00:20,460
[Music]

8
00:00:24,710 --> 00:00:22,800
hello everyone and a very pleasant good

9
00:00:26,630 --> 00:00:24,720
evening to you wherever you may be I am

10
00:00:29,089 --> 00:00:26,640
Brian White from jpl's Office of

11
00:00:31,189 --> 00:00:29,099
communications and educations and

12
00:00:33,110 --> 00:00:31,199
welcome to the Von Carmen series it has

13
00:00:35,750 --> 00:00:33,120

been a pleasure and an honor to bring

14
00:00:37,490 --> 00:00:35,760
these talks to you in the 1930s a group

15
00:00:39,590 --> 00:00:37,500
of amateur rocket enthusiasts nicknamed

16
00:00:41,990 --> 00:00:39,600
The Suicide Squad essentially founded

17
00:00:44,209 --> 00:00:42,000
NASA's jet propulsion laboratory their

18
00:00:45,170 --> 00:00:44,219
goal was to do the impossible to reach

19
00:00:47,270 --> 00:00:45,180
Beyond

20
00:00:48,889 --> 00:00:47,280
JPL today is the leading Center for

21
00:00:51,290 --> 00:00:48,899
robotic exploration of the solar system

22
00:00:53,630 --> 00:00:51,300
daily region for that Beyond and making

23
00:00:55,130 --> 00:00:53,640
it possible from landing on Mars to

24
00:00:57,650 --> 00:00:55,140
visiting every planet in the solar

25
00:00:59,630 --> 00:00:57,660
system to voyager's faint whisperings at

26
00:01:01,910 --> 00:00:59,640
the edge of the solar system

27
00:01:05,090 --> 00:01:01,920
the JPL model taken from the man in the

28
00:01:06,289 --> 00:01:05,100
arena speech is dare Mighty things I am

29
00:01:07,910 --> 00:01:06,299
grateful there are these amazing human

30
00:01:10,730 --> 00:01:07,920
beings that dare these mightiest of

31
00:01:12,230 --> 00:01:10,740
things and create the next tonight we'll

32
00:01:14,210 --> 00:01:12,240
talk with one of our robotic Mobility

33
00:01:15,770 --> 00:01:14,220
Engineers about the importance of

34
00:01:18,649 --> 00:01:15,780
autonomy in these groundbreaking

35
00:01:21,590 --> 00:01:18,659
missions and how they help us with the

36
00:01:22,969 --> 00:01:21,600
ever-present question of what's next and

37
00:01:24,649 --> 00:01:22,979
before we go any further I'd like to

38
00:01:26,390 --> 00:01:24,659

introduce our questions co-host for this

39
00:01:29,149 --> 00:01:26,400
evening she is the lead producer for the

40
00:01:30,530 --> 00:01:29,159
studio here at JPL please welcome Rachel

41
00:01:33,530 --> 00:01:30,540
Etheridge

42
00:01:36,710 --> 00:01:33,540
hi Rachel thank you hi

43
00:01:39,950 --> 00:01:36,720
much Brian and hi everybody out there

44
00:01:46,550 --> 00:01:43,850
I this is your space program we want you

45
00:01:48,590 --> 00:01:46,560
to be involved with this conversation so

46
00:01:52,249 --> 00:01:48,600
whether you're watching on YouTube or

47
00:01:55,190 --> 00:01:52,259
Facebook live or LinkedIn ask questions

48
00:01:58,730 --> 00:01:55,200
in the chat box and our social media

49
00:02:01,010 --> 00:01:58,740
team who are at the ready will bring in

50
00:02:03,350 --> 00:02:01,020
as many as we can in our talk tonight

51
00:02:05,749 --> 00:02:03,360
and if you don't see the chat box just

52
00:02:09,169 --> 00:02:05,759
reload your page and it should be right

53
00:02:11,449 --> 00:02:09,179
there on a more personal note Hiro and I

54
00:02:13,729 --> 00:02:11,459
have been working closely together for

55
00:02:15,890 --> 00:02:13,739
over two years now and I'm just so

56
00:02:18,110 --> 00:02:15,900
excited to be able to bring your

57
00:02:21,350 --> 00:02:18,120
questions to a hero who's our speaker

58
00:02:24,110 --> 00:02:21,360
tonight back to you Brian

59
00:02:26,150 --> 00:02:24,120
thank you very much Rachel and that's a

60
00:02:27,650 --> 00:02:26,160
pretty good intro we're going to get

61
00:02:30,949 --> 00:02:27,660
into his bio as we go through the story

62
00:02:32,770 --> 00:02:30,959
but please welcome Dr Hiro Ono hi hero

63
00:02:36,110 --> 00:02:32,780

hello

64
00:02:38,809 --> 00:02:36,120
Ryan how's it going and hi Rachel

65
00:02:40,670 --> 00:02:38,819
it's going wonderfully let's let's just

66
00:02:41,990 --> 00:02:40,680
Dive Right In because when we're talking

67
00:02:43,790 --> 00:02:42,000
about the future we're talking about

68
00:02:46,550 --> 00:02:43,800
what's next we got to talk about where

69
00:02:47,990 --> 00:02:46,560
we came from right so here are tell me

70
00:02:49,490 --> 00:02:48,000
how you got here tell me how you ended

71
00:02:52,910 --> 00:02:49,500
up working at JPL

72
00:02:55,550 --> 00:02:52,920
yeah it's a long story but that stars

73
00:02:57,949 --> 00:02:55,560
when I was five years old you know my

74
00:02:59,750 --> 00:02:57,959
father was basically a space geek you

75
00:03:02,330 --> 00:02:59,760
know so you know if you ring at the

76
00:03:05,470 --> 00:03:02,340
first slide you know he bought me this

77
00:03:08,390 --> 00:03:05,480
telescope when I was five and we spend

78
00:03:09,170 --> 00:03:08,400
many many hours right

79
00:03:11,330 --> 00:03:09,180
um

80
00:03:13,070 --> 00:03:11,340
you know to look at stars look at

81
00:03:16,369 --> 00:03:13,080
planets look at the Moon bring up a

82
00:03:21,110 --> 00:03:16,379
Saturn you know that

83
00:03:24,170 --> 00:03:21,120
and then when I was six years old

84
00:03:27,649 --> 00:03:24,180
this spacecraft called Voyager 2. when

85
00:03:30,530 --> 00:03:27,659
the Neptune there was a 1989.

86
00:03:33,649 --> 00:03:30,540
maybe uh some of the listeners are

87
00:03:37,369 --> 00:03:33,659
still remember that was a sensational

88
00:03:39,470 --> 00:03:37,379

you know news to me to my father we

89
00:03:41,990 --> 00:03:39,480
again spend a lot of hours in for the TV

90
00:03:43,130 --> 00:03:42,000
you know looking at you know watching

91
00:03:46,130 --> 00:03:43,140
the news

92
00:03:48,050 --> 00:03:46,140
following what's going on and you know

93
00:03:50,570 --> 00:03:48,060
um I remember

94
00:03:53,930 --> 00:03:50,580
one thing that my father told me right

95
00:03:57,430 --> 00:03:53,940
now you know when watching about Voyager

96
00:03:59,630 --> 00:03:57,440
if you you know shrink the solar system

97
00:04:03,530 --> 00:03:59,640
you know

98
00:04:06,009 --> 00:04:03,540
so that the Earth is the size of this

99
00:04:09,830 --> 00:04:06,019
tiny marble ball you know

100
00:04:12,530 --> 00:04:09,840
then how far you think the Neptune would

101
00:04:17,270 --> 00:04:15,530
three miles oh of course you know I grew

102
00:04:19,909 --> 00:04:17,280
up in Tokyo Japan where my accent comes

103
00:04:22,490 --> 00:04:19,919
from so he didn't say three miles he

104
00:04:24,409 --> 00:04:22,500
said five kilometers but anyways can you

105
00:04:27,490 --> 00:04:24,419
imagine you know imagine that this Earth

106
00:04:30,710 --> 00:04:27,500
is you know this tiny marble ball right

107
00:04:32,810 --> 00:04:30,720
and then this spacecraft

108
00:04:35,629 --> 00:04:32,820
flew like you know all the way through

109
00:04:37,790 --> 00:04:35,639
across the solar system spending 12

110
00:04:39,890 --> 00:04:37,800
years to get there or reach to this

111
00:04:41,810 --> 00:04:39,900
beautiful blue planet and send pictures

112
00:04:45,170 --> 00:04:41,820
back

113
00:04:47,270 --> 00:04:45,180

you know this is so amazing and you know

114
00:04:52,249 --> 00:04:47,280
somehow I've heard that this spacecraft

115
00:04:54,530 --> 00:04:52,259
was created by this place called JPL so

116
00:04:56,210 --> 00:04:54,540
you know since then I thought uh you

117
00:04:58,430 --> 00:04:56,220
know when I grow up I wanna

118
00:05:01,070 --> 00:04:58,440
build a spacecraft like Voyager you know

119
00:05:03,290 --> 00:05:01,080
JBL has been a dream twist since then

120
00:05:07,370 --> 00:05:03,300
and 24 years later

121
00:05:09,770 --> 00:05:07,380
you know luckily I arrived at my

122
00:05:12,469 --> 00:05:09,780
childhood dream place and here I am

123
00:05:15,770 --> 00:05:12,479
so if this is your dream place

124
00:05:17,510 --> 00:05:15,780
um how did you get doing we've talked

125
00:05:19,909 --> 00:05:17,520
kind of leading up to this about how you

126
00:05:21,230 --> 00:05:19,919
get to do your dream job every day how

127
00:05:22,790 --> 00:05:21,240
do you how did you get interested in

128
00:05:25,730 --> 00:05:22,800
autonomy how did you get interested in

129
00:05:28,370 --> 00:05:25,740
this specific part of it yeah that's

130
00:05:29,210 --> 00:05:28,380
more like you know maybe there's there's

131
00:05:31,850 --> 00:05:29,220
not

132
00:05:33,950 --> 00:05:31,860
singular point but maybe you know one

133
00:05:36,710 --> 00:05:33,960
turning point was that you know when I

134
00:05:38,990 --> 00:05:36,720
was 12 my father gave me this you know

135
00:05:42,710 --> 00:05:39,000
second hand laptop you know she worked

136
00:05:44,450 --> 00:05:42,720
for Toshiba uh so that was for shivas I

137
00:05:47,029 --> 00:05:44,460
forgot the model number but that's the

138
00:05:49,310 --> 00:05:47,039

one before window so there's no windows

139
00:05:52,270 --> 00:05:49,320
Macintosh everything is in command line

140
00:05:56,029 --> 00:05:52,280
so I got his second hand laptop and he

141
00:05:58,850 --> 00:05:56,039
you know also gave me this book about c

142
00:06:01,610 --> 00:05:58,860
c language program language and somehow

143
00:06:03,290 --> 00:06:01,620
I got into it you know you type in

144
00:06:05,689 --> 00:06:03,300
command you know you make the program

145
00:06:08,570 --> 00:06:05,699
and then computer moves as I instructed

146
00:06:10,189 --> 00:06:08,580
you know so that was my first time you

147
00:06:12,290 --> 00:06:10,199
know what I did that time was basically

148
00:06:14,210 --> 00:06:12,300
creating games right

149
00:06:19,070 --> 00:06:14,220
that's all kids do when speaking of

150
00:06:22,909 --> 00:06:19,080
programs but then you know uh yeah as I

151
00:06:25,249 --> 00:06:22,919
you know go to college grad school I I

152
00:06:27,409 --> 00:06:25,259
found my passion to you know this

153
00:06:30,529 --> 00:06:27,419
machine intelligence so

154
00:06:32,390 --> 00:06:30,539
that's that's how I come to each other

155
00:06:35,510 --> 00:06:32,400
so you're interested in programming

156
00:06:38,210 --> 00:06:35,520
let's talk about why let's combine new

157
00:06:39,590 --> 00:06:38,220
and the amazing person that you are and

158
00:06:42,110 --> 00:06:39,600
the amazing thing that they're doing

159
00:06:43,730 --> 00:06:42,120
here at JPL why is this important to

160
00:06:45,890 --> 00:06:43,740
exploration

161
00:06:49,010 --> 00:06:45,900
yeah you know

162
00:06:51,770 --> 00:06:49,020
think about who are the best explorers

163
00:06:55,189 --> 00:06:51,780

on Earth

164
00:06:58,189 --> 00:06:55,199
it's humans right human beings because

165
00:07:00,529 --> 00:06:58,199
we topped the highest mountain we Dove

166
00:07:03,830 --> 00:07:00,539
to the deepest part of the ocean we flew

167
00:07:09,529 --> 00:07:03,840
the sky we even went to the moon but you

168
00:07:10,730 --> 00:07:09,539
know what makes humans the best Explorer

169
00:07:13,909 --> 00:07:10,740
right

170
00:07:16,010 --> 00:07:13,919
it's we are not the species that can run

171
00:07:19,790 --> 00:07:16,020
fastest you know we are not a species

172
00:07:21,650 --> 00:07:19,800
that can you know swim you know fly you

173
00:07:24,290 --> 00:07:21,660
know it's not the physical capability

174
00:07:26,809 --> 00:07:24,300
it's the intelligence right it's our

175
00:07:29,990 --> 00:07:26,819
intelligence that makes us the best

176
00:07:32,270 --> 00:07:30,000
Explorer so now you know we we want to

177
00:07:33,830 --> 00:07:32,280
make the robotic Explorer of course you

178
00:07:35,809 --> 00:07:33,840
know our robot has to be physically

179
00:07:37,550 --> 00:07:35,819
capable to go through the space you know

180
00:07:39,589 --> 00:07:37,560
um it has to survive the environment for

181
00:07:42,830 --> 00:07:39,599
sure but

182
00:07:45,469 --> 00:07:42,840
that's not all right you know we

183
00:07:47,150 --> 00:07:45,479
eventually want to explore you know what

184
00:07:48,409 --> 00:07:47,160
want the robots to explore the space

185
00:07:51,170 --> 00:07:48,419
like us

186
00:07:52,909 --> 00:07:51,180
so therefore we need intelligence for

187
00:07:54,710 --> 00:07:52,919
those robots

188
00:07:56,510 --> 00:07:54,720

well let's talk about that intelligence

189
00:07:58,850 --> 00:07:56,520
I mean it sounds science fiction when

190
00:08:00,950 --> 00:07:58,860
you when you use the phrase intelligence

191
00:08:03,589 --> 00:08:00,960
I mean is this becoming real is this

192
00:08:06,170 --> 00:08:03,599
becoming new what's going on here yeah

193
00:08:08,150 --> 00:08:06,180
right it may sound scary right but

194
00:08:10,070 --> 00:08:08,160
actually you know

195
00:08:13,129 --> 00:08:10,080
um

196
00:08:15,589 --> 00:08:13,139
almost oh maybe all spacecrafts that

197
00:08:16,430 --> 00:08:15,599
flown before are moral is autonomous

198
00:08:18,230 --> 00:08:16,440
right

199
00:08:19,790 --> 00:08:18,240
um so you know if you open up the slide

200
00:08:22,430 --> 00:08:19,800
three I believe

201
00:08:25,189 --> 00:08:22,440
um yeah there you go the interesting

202
00:08:29,390 --> 00:08:25,199
fact is that the very first spacecraft

203
00:08:32,630 --> 00:08:29,400
that we launched were fully autonomous

204
00:08:35,810 --> 00:08:32,640
you know examples are our very first

205
00:08:37,990 --> 00:08:35,820
spacecraft the American first spacecraft

206
00:08:41,269 --> 00:08:38,000
um Explorer one

207
00:08:43,130 --> 00:08:41,279
and explore four is the one with you

208
00:08:45,290 --> 00:08:43,140
know kind of pencil shaped one actually

209
00:08:47,570 --> 00:08:45,300
can you move to the next slide this is

210
00:08:50,990 --> 00:08:47,580
an interesting one actually and this was

211
00:08:53,509 --> 00:08:51,000
the very first probe that went to the

212
00:08:56,269 --> 00:08:53,519
moon and its mission was to you know

213
00:08:58,190 --> 00:08:56,279

take a single photo of the Moon but you

214
00:09:00,110 --> 00:08:58,200
know around that time there's no

215
00:09:02,750 --> 00:09:00,120
computer on board right there's even no

216
00:09:05,389 --> 00:09:02,760
receivers meaning that we cannot send

217
00:09:07,070 --> 00:09:05,399
any commands once you launch it the only

218
00:09:09,050 --> 00:09:07,080
thing we can do on the ground is to keep

219
00:09:11,750 --> 00:09:09,060
receiving the signal from it

220
00:09:13,009 --> 00:09:11,760
so how does it work how did they plan to

221
00:09:16,250 --> 00:09:13,019
take a photo of the Moon with the

222
00:09:18,230 --> 00:09:16,260
spacecraft right they have a sensor that

223
00:09:20,110 --> 00:09:18,240
you know catches the moon's light so

224
00:09:24,009 --> 00:09:20,120
basically it reacts to the Moonlight

225
00:09:27,110 --> 00:09:24,019
romantic okay then you know um act based

226
00:09:27,850 --> 00:09:27,120
you know uh the photo uh resistor or

227
00:09:30,170 --> 00:09:27,860
something

228
00:09:32,389 --> 00:09:30,180
which would still go well but you know

229
00:09:35,449 --> 00:09:32,399
that was the you know fully autonomous

230
00:09:38,030 --> 00:09:35,459
and possibly dumb spacecraft you know

231
00:09:40,090 --> 00:09:38,040
way before and then can you move back to

232
00:09:45,250 --> 00:09:40,100
slide three

233
00:09:47,930 --> 00:09:45,260
around early 1960s there's a revolution

234
00:09:50,090 --> 00:09:47,940
caused by digital computer there was the

235
00:09:52,610 --> 00:09:50,100
time when digital computer was available

236
00:09:54,889 --> 00:09:52,620
for spacecraft for the first time around

237
00:09:58,850 --> 00:09:54,899
the time Apollo

238
00:10:00,590 --> 00:09:58,860

so now with the onboard computer

239
00:10:03,370 --> 00:10:00,600
combined with receiver

240
00:10:07,190 --> 00:10:03,380
we can first you know

241
00:10:08,870 --> 00:10:07,200
become capable to send commands to the

242
00:10:11,630 --> 00:10:08,880
space that has already been launched

243
00:10:13,730 --> 00:10:11,640
before right so this is this is

244
00:10:16,910 --> 00:10:13,740
revolutionary because split scratch was

245
00:10:19,250 --> 00:10:16,920
still dumb but we can now we become

246
00:10:22,730 --> 00:10:19,260
capable of projecting our intelligence

247
00:10:26,449 --> 00:10:22,740
right to space basically you know making

248
00:10:30,350 --> 00:10:26,459
the spacecrafts our Avatar right so

249
00:10:32,810 --> 00:10:30,360
that enabled us to do much more complex

250
00:10:35,030 --> 00:10:32,820
exploration and there was a time you

251
00:10:36,290 --> 00:10:35,040
know when Voyager was there but still

252
00:10:37,150 --> 00:10:36,300
you know

253
00:10:39,829 --> 00:10:37,160
um

254
00:10:43,070 --> 00:10:39,839
like Voyager has its own onboard

255
00:10:45,410 --> 00:10:43,080
autonomy uh the example was that you

256
00:10:48,530 --> 00:10:45,420
know when Voyager 2 was launched right

257
00:10:50,810 --> 00:10:48,540
after that one of the receivers dead so

258
00:10:53,269 --> 00:10:50,820
on board algorithm you know was pretty

259
00:10:56,810 --> 00:10:53,279
simple if then rule but it switched back

260
00:10:58,730 --> 00:10:56,820
to switch to the backup receiver which

261
00:11:00,350 --> 00:10:58,740
saved the spacecraft and you know the

262
00:11:02,509 --> 00:11:00,360
Voyager so it's still flying on the back

263
00:11:03,889 --> 00:11:02,519

of receiver for 45 years which is

264
00:11:05,449 --> 00:11:03,899
amazing

265
00:11:07,850 --> 00:11:05,459
pretty grateful to hear that as I'm

266
00:11:10,310 --> 00:11:07,860
wearing my Voyager 45 year pin right

267
00:11:12,110 --> 00:11:10,320
here oh yeah so we're talking about

268
00:11:14,569 --> 00:11:12,120
Voyager we're talking about

269
00:11:16,009 --> 00:11:14,579
I mean where are we now with autonomy I

270
00:11:17,329 --> 00:11:16,019
mean that's an amazing chart but where

271
00:11:21,350 --> 00:11:17,339
are we today

272
00:11:23,990 --> 00:11:21,360
exactly so I you know this chart is kind

273
00:11:26,470 --> 00:11:24,000
of the rough sketch but we see the the

274
00:11:30,130 --> 00:11:26,480
the the trend is inversed you know

275
00:11:33,889 --> 00:11:30,140
invert there now we observe the The

276
00:11:37,310 --> 00:11:33,899
increased level of autonomy again you

277
00:11:38,990 --> 00:11:37,320
know and probably the perseverance robot

278
00:11:41,090 --> 00:11:39,000
you know the Mars rover that landed on

279
00:11:42,470 --> 00:11:41,100
Mars like two years ago or so but I

280
00:11:44,389 --> 00:11:42,480
think it's just it's just a little bit

281
00:11:47,090 --> 00:11:44,399
more than two years right um

282
00:11:49,850 --> 00:11:47,100
I think that's the that's one of the

283
00:11:52,370 --> 00:11:49,860
smartest spacecrafts that uh ever flown

284
00:11:54,590 --> 00:11:52,380
through the world is so far

285
00:11:58,430 --> 00:11:54,600
um let's go to slide

286
00:12:02,150 --> 00:11:58,440
five uh there are few notable

287
00:12:05,810 --> 00:12:02,160
capabilities but one of them that I was

288
00:12:08,449 --> 00:12:05,820

deeply involved was automous driving

289
00:12:10,690 --> 00:12:08,459
you know these days uh you know the cars

290
00:12:13,069 --> 00:12:10,700
uh on Earth start driving

291
00:12:15,290 --> 00:12:13,079
semi-automously but you know the fun

292
00:12:18,350 --> 00:12:15,300
fact is that we've been driving on Mars

293
00:12:22,250 --> 00:12:18,360
autonomously at least in part since uh I

294
00:12:25,130 --> 00:12:22,260
think 15 years ago or so uh but for this

295
00:12:28,130 --> 00:12:25,140
Mission the prosperous transmission we

296
00:12:30,949 --> 00:12:28,140
knew that that we need to substantially

297
00:12:33,829 --> 00:12:30,959
extend enhance the capability of almost

298
00:12:36,829 --> 00:12:33,839
driving to achieve its goal so you know

299
00:12:37,910 --> 00:12:36,839
that's one of my contributions to this

300
00:12:39,530 --> 00:12:37,920
Mission

301
00:12:41,509 --> 00:12:39,540
um this map

302
00:12:45,050 --> 00:12:41,519
it's that you know basically a Drive map

303
00:12:50,090 --> 00:12:45,060
of perseverance we landed on the place

304
00:12:53,389 --> 00:12:50,100
called Jesus crater which uh was a lake

305
00:12:55,610 --> 00:12:53,399
lake with water you know some I guess

306
00:12:59,210 --> 00:12:55,620
four billion years ago or so therefore

307
00:13:02,810 --> 00:12:59,220
some scientists suspect that we

308
00:13:05,449 --> 00:13:02,820
might be able to find the you know the

309
00:13:08,030 --> 00:13:05,459
evidence of the past life that might

310
00:13:10,069 --> 00:13:08,040
have existed on Mars here in this place

311
00:13:12,190 --> 00:13:10,079
anyways so

312
00:13:15,069 --> 00:13:12,200
we landed at

313
00:13:17,930 --> 00:13:15,079

the place where this arrow is pointing

314
00:13:20,690 --> 00:13:17,940
and we first have moved to the South

315
00:13:23,629 --> 00:13:20,700
moved a bit to the west and you know

316
00:13:26,750 --> 00:13:23,639
took few samples we've moved back to The

317
00:13:30,410 --> 00:13:26,760
Landing site and then you know uh drove

318
00:13:34,009 --> 00:13:30,420
kind of counterclockwise to a a go

319
00:13:34,970 --> 00:13:34,019
towards the north uh West Direction

320
00:13:36,590 --> 00:13:34,980
um

321
00:13:38,629 --> 00:13:36,600
each thought

322
00:13:41,690 --> 00:13:38,639
on this map represents the position of

323
00:13:43,610 --> 00:13:41,700
the robot for each Soul version day and

324
00:13:45,110 --> 00:13:43,620
note that at the beginning you know

325
00:13:47,269 --> 00:13:45,120
these thoughts are pretty dense right

326
00:13:50,210 --> 00:13:47,279
meaning that the robot was driving

327
00:13:53,470 --> 00:13:50,220
pretty slowly after we came back to The

328
00:13:56,150 --> 00:13:53,480
Landing site and then you know

329
00:13:58,310 --> 00:13:56,160
observed that it start is very sparse

330
00:14:00,590 --> 00:13:58,320
meaning that drive the war was driving

331
00:14:03,170 --> 00:14:00,600
pretty quickly around that time robots

332
00:14:06,829 --> 00:14:03,180
Rob around 200 meters per Merchant day

333
00:14:08,930 --> 00:14:06,839
or which is about you know 100 and I

334
00:14:11,470 --> 00:14:08,940
don't know I'm I'm a good at conversion

335
00:14:13,790 --> 00:14:11,480
between meat and feet

336
00:14:15,110 --> 00:14:13,800
you're working for now you could work in

337
00:14:17,030 --> 00:14:15,120
the metric you don't have to do it the

338
00:14:17,690 --> 00:14:17,040

other way exactly right

339
00:14:20,449 --> 00:14:17,700
um

340
00:14:24,350 --> 00:14:20,459
anyway so that was the time when we

341
00:14:26,690 --> 00:14:24,360
called drive drive campaign we fully

342
00:14:30,230 --> 00:14:26,700
utilized this uh you know enhanced

343
00:14:33,530 --> 00:14:30,240
alternative capability to push your

344
00:14:36,490 --> 00:14:33,540
limits to uh to drive as as fast as

345
00:14:40,069 --> 00:14:36,500
possible and uh

346
00:14:42,170 --> 00:14:40,079
around that time you know uh um we yeah

347
00:14:46,730 --> 00:14:42,180
as I said that we drove around the 200

348
00:14:49,129 --> 00:14:46,740
meters per Soul uh we up till now we

349
00:14:53,810 --> 00:14:49,139
drove about 60 percent of the distance

350
00:14:56,030 --> 00:14:53,820
uh obviously and uh just a few few weeks

351
00:14:58,930 --> 00:14:56,040
ago we again brought the recording of

352
00:15:02,329 --> 00:14:58,940
the driving distance per plan that was

353
00:15:05,090 --> 00:15:02,339
655 meters so we were very happy about

354
00:15:06,410 --> 00:15:05,100
how how much these are new although on

355
00:15:08,930 --> 00:15:06,420
the capability you know pushed

356
00:15:11,569 --> 00:15:08,940
apparently of driving on Mars

357
00:15:14,269 --> 00:15:11,579
Let's uh let's look at the uh movie on

358
00:15:21,290 --> 00:15:16,970
yeah this was a time uh five years ago

359
00:15:24,710 --> 00:15:21,300
you know uh when we worked on the

360
00:15:26,810 --> 00:15:24,720
development of the alternative we this

361
00:15:30,949 --> 00:15:26,820
is a place called Mars yard

362
00:15:33,590 --> 00:15:30,959
um when you know we test these things uh

363
00:15:36,110 --> 00:15:33,600

regularly uh

364
00:15:38,210 --> 00:15:36,120
summer of 2018 was the hottest summer

365
00:15:40,910 --> 00:15:38,220
for us I spent the hundreds of hours

366
00:15:44,329 --> 00:15:40,920
with my colleagues I'll leave you to pad

367
00:15:46,009 --> 00:15:44,339
titled system Michael Henry mark my mom

368
00:15:49,850 --> 00:15:46,019
to you know

369
00:15:52,670 --> 00:15:49,860
um test them you know fix the bag you

370
00:15:52,680 --> 00:15:57,110
can you go next please

371
00:16:05,509 --> 00:16:02,210
and then this is not Mars yard on ours

372
00:16:06,430 --> 00:16:05,519
this is real Mars This is the

373
00:16:11,930 --> 00:16:06,440
um

374
00:16:15,110 --> 00:16:11,940
uh real movie uh came out from Seoul 360

375
00:16:19,370 --> 00:16:15,120
drive that was I think about again 200

376
00:16:21,829 --> 00:16:19,380
meter Drive uh yes we are driving

377
00:16:23,870 --> 00:16:21,839
very nicely

378
00:16:27,829 --> 00:16:23,880
and I think there's one more slide about

379
00:16:34,610 --> 00:16:31,790
yeah so this is the 3D reconstruction of

380
00:16:38,389 --> 00:16:34,620
from the driving data I fought for we

381
00:16:41,810 --> 00:16:38,399
saw yes so yeah you know autonomy is

382
00:16:42,949 --> 00:16:41,820
helping Mars robot to drive faster and

383
00:16:46,490 --> 00:16:42,959
further

384
00:16:49,810 --> 00:16:46,500
another thing to note is that autonomy

385
00:16:52,730 --> 00:16:49,820
also helped landing on Mars

386
00:16:55,249 --> 00:16:52,740
which was the kirability called trm

387
00:16:57,350 --> 00:16:55,259
terrain relative navigation which I was

388
00:16:59,930 --> 00:16:57,360

not involved but you know that's

389
00:17:03,050 --> 00:16:59,940
basically ability to allow us to you

390
00:17:05,750 --> 00:17:03,060
know land uh avoid the dangerous Landing

391
00:17:09,470 --> 00:17:05,760
site and you know land on a safe place

392
00:17:11,929 --> 00:17:09,480
so yes autonomy you know means a lot for

393
00:17:14,210 --> 00:17:11,939
for the smart smartphone machine so

394
00:17:15,530 --> 00:17:14,220
autonomy is huge for right now it's huge

395
00:17:19,010 --> 00:17:15,540
for these missions that we're working on

396
00:17:20,510 --> 00:17:19,020
at this moment something that these VK

397
00:17:22,669 --> 00:17:20,520
talks that we've tried to do is also

398
00:17:26,569 --> 00:17:22,679
remind people of the human element

399
00:17:27,890 --> 00:17:26,579
behind Robotics and autonomy this is a

400
00:17:29,810 --> 00:17:27,900
special mission for you in particular

401
00:17:32,990 --> 00:17:29,820
right the Mars 2020 mission

402
00:17:36,350 --> 00:17:33,000
yeah there was a uh quite a bit of a

403
00:17:38,930 --> 00:17:36,360
personal story again

404
00:17:41,270 --> 00:17:38,940
um you know since Voyager of course I

405
00:17:43,310 --> 00:17:41,280
you know took a close watch on all the

406
00:17:45,490 --> 00:17:43,320
uh you know NASA JP open tradition right

407
00:17:50,330 --> 00:17:45,500
imagine

408
00:17:51,770 --> 00:17:50,340
and uh in 1997 that that's when I was 14

409
00:17:54,110 --> 00:17:51,780
years old I believe

410
00:17:55,490 --> 00:17:54,120
the most Pathfinder the little Mars

411
00:17:58,010 --> 00:17:55,500
right um

412
00:18:01,250 --> 00:17:58,020
that was the first landing of Mars since

413
00:18:05,750 --> 00:18:01,260

Viking first Mars Landing that they've

414
00:18:07,549 --> 00:18:05,760
seen and so I was done on TV

415
00:18:08,990 --> 00:18:07,559
um you know there was this seven myths

416
00:18:10,909 --> 00:18:09,000
of Terror you know the seven minutes

417
00:18:13,610 --> 00:18:10,919
right before the landing where you can

418
00:18:15,289 --> 00:18:13,620
not talk to spacecraft so the only thing

419
00:18:16,190 --> 00:18:15,299
that the people on the ground can do is

420
00:18:18,770 --> 00:18:16,200
to wait

421
00:18:20,870 --> 00:18:18,780
so you know uh people waited right

422
00:18:23,950 --> 00:18:20,880
anxiously right you know hey what's

423
00:18:30,230 --> 00:18:28,490
did it go well and the moment you know

424
00:18:33,770 --> 00:18:30,240
they

425
00:18:36,590 --> 00:18:33,780
heard from the Pathfinder the

426
00:18:38,450 --> 00:18:36,600
confirmation signal of Landing these

427
00:18:40,190 --> 00:18:38,460
people can immediately jumped around

428
00:18:42,350 --> 00:18:40,200
right you know jumped around and hearing

429
00:18:44,690 --> 00:18:42,360
around and you know someone even cried

430
00:18:47,570 --> 00:18:44,700
hugging each other right

431
00:18:50,350 --> 00:18:47,580
um so I was like wow you know I've never

432
00:18:53,990 --> 00:18:50,360
seen grown-ups you know

433
00:18:55,190 --> 00:18:54,000
jumping like kids like that wow that's

434
00:18:57,049 --> 00:18:55,200
something that I want to see in the

435
00:19:00,289 --> 00:18:57,059
future

436
00:19:01,909 --> 00:19:00,299
um and then um yeah actually yeah I I

437
00:19:03,770 --> 00:19:01,919
think we have a slide

438
00:19:05,990 --> 00:19:03,780

um which is site nine

439
00:19:08,270 --> 00:19:06,000
can you move there yeah there you go

440
00:19:10,130 --> 00:19:08,280
that was curiosity but then you know the

441
00:19:12,710 --> 00:19:10,140
the next one was spirit and opportunity

442
00:19:13,610 --> 00:19:12,720
that was 2004 so I was a junior in

443
00:19:16,850 --> 00:19:13,620
college

444
00:19:19,370 --> 00:19:16,860
this happened again right so okay I

445
00:19:23,510 --> 00:19:19,380
thought I'm gonna joined them so after

446
00:19:27,110 --> 00:19:23,520
my college I came to the U.S for

447
00:19:28,970 --> 00:19:27,120
graduate school and got PhD and I

448
00:19:32,750 --> 00:19:28,980
thought the time is ripe so I know if

449
00:19:35,270 --> 00:19:32,760
the door of JPL either with you know

450
00:19:37,070 --> 00:19:35,280
but I didn't get offer that time

451
00:19:39,590 --> 00:19:37,080
um so you know I I was kind of

452
00:19:42,950 --> 00:19:39,600
brokenhearted I went back to Japan and I

453
00:19:46,909 --> 00:19:42,960
got a a university job over there that

454
00:19:49,610 --> 00:19:46,919
was 2012. that was when curiosity landed

455
00:19:53,029 --> 00:19:49,620
on Mars so you know yeah this picture

456
00:19:55,730 --> 00:19:53,039
was from Curiosity I watched it you know

457
00:19:58,730 --> 00:19:55,740
I watched the uh the webcast on my

458
00:19:59,810 --> 00:19:58,740
laptop in the school cafeteria and I was

459
00:20:02,330 --> 00:19:59,820
like you know

460
00:20:04,789 --> 00:20:02,340
what what I'm doing here right I thought

461
00:20:06,289 --> 00:20:04,799
I was going to join them but you know

462
00:20:08,390 --> 00:20:06,299
I'm still on the other side of the

463
00:20:11,930 --> 00:20:08,400

screen so yeah

464
00:20:14,870 --> 00:20:11,940
yeah but then you know luckily for uh

465
00:20:16,789 --> 00:20:14,880
thanks to a few lucky turns of events I

466
00:20:18,950 --> 00:20:16,799
got a second chance and you know I

467
00:20:21,770 --> 00:20:18,960
interviewed with jpo again that time I

468
00:20:25,490 --> 00:20:21,780
finally you know I got an offer so

469
00:20:28,490 --> 00:20:25,500
that was again 24 years after Voyager

470
00:20:30,770 --> 00:20:28,500
two so you know after I joined JPL I

471
00:20:35,330 --> 00:20:30,780
worked on Mars 2020 mission

472
00:20:37,610 --> 00:20:35,340
on many aspects and you know uh a few

473
00:20:39,950 --> 00:20:37,620
years ago I finally you know could join

474
00:20:42,470 --> 00:20:39,960
the sublation uh

475
00:20:46,430 --> 00:20:42,480
that that was during the call of it so I

476
00:20:48,370 --> 00:20:46,440
cannot see it on the lab instead I you

477
00:20:55,210 --> 00:20:48,380
know somebody from home but can you

478
00:20:55,220 --> 00:20:59,870
like 10 I believe

479
00:21:05,390 --> 00:21:01,810
yeah so

480
00:21:06,950 --> 00:21:05,400
that's uh when I celebrated with my

481
00:21:09,650 --> 00:21:06,960
family

482
00:21:12,650 --> 00:21:09,660
in a super messy living room of course

483
00:21:14,210 --> 00:21:12,660
because I my daughter was four years old

484
00:21:15,950 --> 00:21:14,220
your living room must be like this

485
00:21:18,110 --> 00:21:15,960
during call of it when you have a girl

486
00:21:21,350 --> 00:21:18,120
or boy

487
00:21:23,450 --> 00:21:21,360
yes yeah so yeah that was a that was my

488
00:21:26,270 --> 00:21:23,460

moment of Lifetime

489
00:21:28,130 --> 00:21:26,280
is a moment of a lifetime and yeah we

490
00:21:28,850 --> 00:21:28,140
all are going through through it but

491
00:21:30,649 --> 00:21:28,860
that's

492
00:21:32,630 --> 00:21:30,659
a credible that you got to celebrate

493
00:21:35,690 --> 00:21:32,640
with your family

494
00:21:37,370 --> 00:21:35,700
um I'm just so happy for you because it

495
00:21:39,049 --> 00:21:37,380
it's never a straight path is it you

496
00:21:40,370 --> 00:21:39,059
always sometimes you have to move to the

497
00:21:42,289 --> 00:21:40,380
left and right and go backwards before

498
00:21:44,090 --> 00:21:42,299
you can come and get to do your dream

499
00:21:45,289 --> 00:21:44,100
job but let's go back all right I wanna

500
00:21:46,430 --> 00:21:45,299
I wanna jump back I want to get back

501
00:21:47,750 --> 00:21:46,440
into this autonomy I want to get back

502
00:21:50,029 --> 00:21:47,760
into the science I want to talk about

503
00:21:52,310 --> 00:21:50,039
talk about that record you just said

504
00:21:53,930 --> 00:21:52,320
because 600 meters you said you didn't

505
00:21:56,330 --> 00:21:53,940
like to do the we'll do it for you it's

506
00:21:58,430 --> 00:21:56,340
about a half a mile right yeah right

507
00:22:00,289 --> 00:21:58,440
it's a half a mile yeah so what's be

508
00:22:02,450 --> 00:22:00,299
what's beyond that what's beyond Mars

509
00:22:05,450 --> 00:22:02,460
2020. yeah right it's half a mile that's

510
00:22:07,190 --> 00:22:05,460
the distance you know basically to the

511
00:22:09,490 --> 00:22:07,200
nearest Trader Joe's from my home you

512
00:22:13,270 --> 00:22:09,500
know okay

513
00:22:16,970 --> 00:22:13,280

yeah so yes you know uh

514
00:22:19,970 --> 00:22:16,980
that is a lot to us but it's not a lot

515
00:22:22,010 --> 00:22:19,980
to you know compared to

516
00:22:25,190 --> 00:22:22,020
how much we can run how much we can

517
00:22:27,350 --> 00:22:25,200
drive on earth right yeah but

518
00:22:30,049 --> 00:22:27,360
obviously here we can do more um there's

519
00:22:33,289 --> 00:22:30,059
an example from the past can you go to

520
00:22:36,350 --> 00:22:33,299
slide 11 you know in Apollo Mission you

521
00:22:38,990 --> 00:22:36,360
know yeah from Apollo 15 to 17 we use

522
00:22:41,990 --> 00:22:39,000
this Luna buggy you know uh astronauts

523
00:22:45,770 --> 00:22:42,000
drove you know uh 10 to 20 kilometers

524
00:22:48,529 --> 00:22:45,780
just in a few days uh the max speed was

525
00:22:51,890 --> 00:22:48,539
12 mile per miles per hour which doesn't

526
00:22:55,490 --> 00:22:51,900
sound very fast but you know remind that

527
00:22:57,529 --> 00:22:55,500
this was not a one thing freeway uh but

528
00:22:59,930 --> 00:22:57,539
by the way you cannot drive 12 miles per

529
00:23:02,930 --> 00:22:59,940
hour on one day freeway when you have a

530
00:23:06,049 --> 00:23:02,940
peak power anyways um North on the moon

531
00:23:11,090 --> 00:23:06,059
and 12 12 miles per hour was like you

532
00:23:13,730 --> 00:23:11,100
know 100 times faster than the modular

533
00:23:15,830 --> 00:23:13,740
um there are many reasons why the buzz

534
00:23:18,950 --> 00:23:15,840
warmer is so slow you know power

535
00:23:22,070 --> 00:23:18,960
availability mechanical reasons but

536
00:23:23,210 --> 00:23:22,080
there's another reason you know uh if

537
00:23:25,909 --> 00:23:23,220
you look cool thing about this picture

538
00:23:29,510 --> 00:23:25,919

you know it has pretty simple Mobility

539
00:23:32,090 --> 00:23:29,520
system combined with very intelligent

540
00:23:35,770 --> 00:23:32,100
perception and planning algorithm but

541
00:23:39,590 --> 00:23:35,780
not in computer and humans neural right

542
00:23:42,230 --> 00:23:39,600
that was one of the keys right so you

543
00:23:43,970 --> 00:23:42,240
know the question is if we can no you

544
00:23:46,549 --> 00:23:43,980
know not completely replicating what

545
00:23:49,310 --> 00:23:46,559
humans can do but at least can we do one

546
00:23:52,130 --> 00:23:49,320
tenth of what humans can do can we get a

547
00:23:53,570 --> 00:23:52,140
little bit closer to what humans can do

548
00:23:56,690 --> 00:23:53,580
than

549
00:23:59,990 --> 00:23:56,700
what most robots are doing so you know

550
00:24:05,690 --> 00:24:00,000
that's uh uh that motivates you know

551
00:24:06,710 --> 00:24:05,700
some of my research uh projects

552
00:24:10,370 --> 00:24:06,720
um

553
00:24:13,730 --> 00:24:10,380
let's go to slide 12.

554
00:24:15,049 --> 00:24:13,740
yeah so uh here's one example you know

555
00:24:18,110 --> 00:24:15,059
when driving

556
00:24:20,210 --> 00:24:18,120
um I'm currently working as a a robot

557
00:24:21,289 --> 00:24:20,220
driver I'm a trainee if I'm being

558
00:24:22,970 --> 00:24:21,299
trained

559
00:24:25,010 --> 00:24:22,980
um you know when we're driving the robot

560
00:24:26,750 --> 00:24:25,020
manually we care a lot about terrains

561
00:24:29,570 --> 00:24:26,760
you know we don't typically don't want

562
00:24:32,330 --> 00:24:29,580
to drive on slippery trains because you

563
00:24:35,270 --> 00:24:32,340

know in the past our robot got stuck in

564
00:24:38,330 --> 00:24:35,280
sand a few times

565
00:24:40,549 --> 00:24:38,340
um so but you know for the on-board

566
00:24:43,190 --> 00:24:40,559
algorithm for the autonomous driving

567
00:24:45,529 --> 00:24:43,200
algorithm it only uses stereo cameras

568
00:24:48,350 --> 00:24:45,539
meaning that it can only use geometric

569
00:24:50,630 --> 00:24:48,360
information it can tell that hey there

570
00:24:52,610 --> 00:24:50,640
are rocks there are you know holes but

571
00:24:54,950 --> 00:24:52,620
they cannot tell like humans hey there

572
00:24:58,130 --> 00:24:54,960
are rocks here there are Sands there you

573
00:25:02,029 --> 00:24:58,140
know if robots can tell the terrain type

574
00:25:04,370 --> 00:25:02,039
by itself then probably can drive safer

575
00:25:08,450 --> 00:25:04,380
and more effient right

576
00:25:11,870 --> 00:25:08,460
so while we uh uh uh did before

577
00:25:15,830 --> 00:25:11,880
um can you go to slice 13. so you know

578
00:25:17,450 --> 00:25:15,840
we trained a neural net uh artificial

579
00:25:22,010 --> 00:25:17,460
neural net

580
00:25:25,190 --> 00:25:22,020
um to you know look at an on-board image

581
00:25:26,590 --> 00:25:25,200
and basically you know classify hey

582
00:25:29,810 --> 00:25:26,600
where are

583
00:25:32,750 --> 00:25:29,820
you know drivable rocks and soils there

584
00:25:34,909 --> 00:25:32,760
are slippery sense

585
00:25:37,250 --> 00:25:34,919
um I did with my many colleagues you

586
00:25:40,970 --> 00:25:37,260
know Diego Nathan like Peyton Michael

587
00:25:44,330 --> 00:25:40,980
Swann uh many other people's um we

588
00:25:48,470 --> 00:25:44,340

implemented that we you know uh also

589
00:25:50,870 --> 00:25:48,480
implemented on his blogger and drove uh

590
00:25:54,169 --> 00:25:50,880
the destroyed river called a real Seiko

591
00:25:58,130 --> 00:25:54,179
right next to JPL uh it went very well

592
00:26:02,690 --> 00:25:58,140
so um that could be one way uh that we

593
00:26:02,700 --> 00:26:06,370
um going to

594
00:26:15,350 --> 00:26:11,690
uh slide 16 please

595
00:26:19,010 --> 00:26:15,360
another thing that uh uh I did with the

596
00:26:22,549 --> 00:26:19,020
deal of color as Sharon staff three uh

597
00:26:25,310 --> 00:26:22,559
Eastern UI and the other people so uh we

598
00:26:27,289 --> 00:26:25,320
thought we maybe you know so

599
00:26:30,890 --> 00:26:27,299
um the the one of the big difference

600
00:26:32,330 --> 00:26:30,900
between you know the uh automatic

601
00:26:35,269 --> 00:26:32,340
algorithm that we are using for

602
00:26:38,330 --> 00:26:35,279
perseverance and humans drivers is that

603
00:26:41,090 --> 00:26:38,340
human has Instinct right right at the

604
00:26:44,029 --> 00:26:41,100
moment when you see the environment

605
00:26:46,190 --> 00:26:44,039
around you you know you can you you can

606
00:26:47,810 --> 00:26:46,200
anything people think hey that's the

607
00:26:50,029 --> 00:26:47,820
wrong that you have to avoid you know

608
00:26:52,370 --> 00:26:50,039
there's an open space over there you

609
00:26:55,310 --> 00:26:52,380
don't have to think much right

610
00:26:57,830 --> 00:26:55,320
so I thought man you know can we

611
00:26:58,430 --> 00:26:57,840
replicate the academic Instinct

612
00:27:01,130 --> 00:26:58,440
um

613
00:27:04,070 --> 00:27:01,140

by using machine learning yes we can we

614
00:27:08,450 --> 00:27:04,080
can train the uh the neural net

615
00:27:10,730 --> 00:27:08,460
um to you know to to tell you know which

616
00:27:12,950 --> 00:27:10,740
part of the the terrains which path

617
00:27:14,990 --> 00:27:12,960
options are more focusing than the

618
00:27:16,610 --> 00:27:15,000
others so that it can accelerate the you

619
00:27:17,690 --> 00:27:16,620
know the planning algorithm

620
00:27:21,350 --> 00:27:17,700
um so

621
00:27:24,289 --> 00:27:21,360
um you know this is just the two um two

622
00:27:26,750 --> 00:27:24,299
of many examples but there are a lot of

623
00:27:29,570 --> 00:27:26,760
possibilities you know uh by applying

624
00:27:32,570 --> 00:27:29,580
the latest Technologies to you know help

625
00:27:33,710 --> 00:27:32,580
future spacecraft or you know safer and

626
00:27:36,169 --> 00:27:33,720
more efficient

627
00:27:37,430 --> 00:27:36,179
well you we in talking about this and

628
00:27:38,930 --> 00:27:37,440
planning this talk I was thinking about

629
00:27:40,549 --> 00:27:38,940
this as I drove home about how

630
00:27:42,110 --> 00:27:40,559
unnaturally know when it hit the brake I

631
00:27:44,810 --> 00:27:42,120
know when to how far away I'm going to

632
00:27:46,970 --> 00:27:44,820
be how you said the word train how do

633
00:27:47,930 --> 00:27:46,980
you teach something like this to a

634
00:27:50,029 --> 00:27:47,940
machine

635
00:27:50,870 --> 00:27:50,039
yeah that's a good question right you

636
00:27:51,730 --> 00:27:50,880
know

637
00:27:55,010 --> 00:27:51,740
um

638
00:27:57,110 --> 00:27:55,020

any of my attempts to teach something to

639
00:27:59,510 --> 00:27:57,120
my daughter visually failed so I know

640
00:28:02,090 --> 00:27:59,520
how hard it is to teach right uh

641
00:28:02,930 --> 00:28:02,100
something to you know

642
00:28:05,390 --> 00:28:02,940
um

643
00:28:07,190 --> 00:28:05,400
well at least uh artificial neonate is

644
00:28:11,149 --> 00:28:07,200
not as rebellious as my daughter so

645
00:28:14,230 --> 00:28:11,159
maybe that uh anyways so

646
00:28:16,730 --> 00:28:14,240
um yeah but you know training the um

647
00:28:19,070 --> 00:28:16,740
Archer neural net particularly deep

648
00:28:21,289 --> 00:28:19,080
neural net

649
00:28:23,210 --> 00:28:21,299
um is challenging because it requires a

650
00:28:25,669 --> 00:28:23,220
huge amount of data

651
00:28:29,269 --> 00:28:25,679
much more than you know your kids

652
00:28:31,250 --> 00:28:29,279
require so in the case of terrain

653
00:28:33,830 --> 00:28:31,260
classification for example right you

654
00:28:35,990 --> 00:28:33,840
know you typically need you know tens of

655
00:28:37,149 --> 00:28:36,000
thousands maybe hundreds of thousands of

656
00:28:41,990 --> 00:28:37,159
examples

657
00:28:44,210 --> 00:28:42,000
to make it uh you know reliable so where

658
00:28:46,070 --> 00:28:44,220
we can get that data right um so that

659
00:28:48,769 --> 00:28:46,080
was one of the challenge that we faced

660
00:28:51,230 --> 00:28:48,779
uh we tried a few different things but

661
00:28:54,830 --> 00:28:51,240
in the end what worked very well was to

662
00:28:57,649 --> 00:28:54,840
get help from people on the internet

663
00:29:00,710 --> 00:28:57,659

can you go to site 14 please

664
00:29:03,590 --> 00:29:00,720
so during covet we launched this project

665
00:29:06,049 --> 00:29:03,600
called AI for Mars on internet

666
00:29:08,990 --> 00:29:06,059
um or the site called zuniverse

667
00:29:11,149 --> 00:29:09,000
basically it's like you know we said hey

668
00:29:14,690 --> 00:29:11,159
everyone on the internet would you

669
00:29:16,190 --> 00:29:14,700
kindly help us to create the the

670
00:29:18,409 --> 00:29:16,200
examples

671
00:29:20,810 --> 00:29:18,419
um to teach the mobile and actually many

672
00:29:22,789 --> 00:29:20,820
people say oh yeah right so it's very

673
00:29:25,669 --> 00:29:22,799
easy you know anyone can go to the site

674
00:29:29,269 --> 00:29:25,679
you can Google AI for Mars for number

675
00:29:33,049 --> 00:29:29,279
four right and you know open this page

676
00:29:37,310 --> 00:29:33,059
and you can view the real images from

677
00:29:39,350 --> 00:29:37,320
Mars and all you are have to do is to

678
00:29:41,990 --> 00:29:39,360
you know put this bounding boxes around

679
00:29:45,049 --> 00:29:42,000
rocks around sand

680
00:29:48,190 --> 00:29:45,059
this training data comes to us

681
00:29:51,230 --> 00:29:48,200
which is used to train our neural net

682
00:29:53,269 --> 00:29:51,240
which might be used in future statecraft

683
00:29:55,370 --> 00:29:53,279
so you know

684
00:29:59,210 --> 00:29:55,380
um I am glad so many people were excited

685
00:30:00,169 --> 00:29:59,220
we uh got I think 50 000 Frontiers in

686
00:30:03,529 --> 00:30:00,179
total

687
00:30:06,289 --> 00:30:03,539
oh my God I think around 600

688
00:30:08,510 --> 00:30:06,299

000 you know labels inputs from people

689
00:30:11,330 --> 00:30:08,520
so I really appreciate you know people's

690
00:30:13,430 --> 00:30:11,340
passion you know to help future

691
00:30:16,730 --> 00:30:13,440
spacecrafts you know make make it

692
00:30:21,830 --> 00:30:19,549
I I like to use the phrase passion there

693
00:30:23,450 --> 00:30:21,840
because we'll we'll do anything for Mars

694
00:30:24,889 --> 00:30:23,460
and for these things but JPL is more

695
00:30:25,730 --> 00:30:24,899
than Mars right we talked about Voyager

696
00:30:28,730 --> 00:30:25,740
we're talking about all these other

697
00:30:31,909 --> 00:30:28,740
places let's go beyond what's how's

698
00:30:34,669 --> 00:30:31,919
autonomy help us beyond the red planet

699
00:30:36,710 --> 00:30:34,679
yeah you know of course Mars is not our

700
00:30:39,830 --> 00:30:36,720
final destination it's it's one of the

701
00:30:42,289 --> 00:30:39,840
closest planets and Beyond the orbital

702
00:30:44,810 --> 00:30:42,299
Mars there are more interesting things

703
00:30:46,370 --> 00:30:44,820
you know unexplored waiting two pieces

704
00:30:49,850 --> 00:30:46,380
of what right

705
00:30:53,210 --> 00:30:49,860
um can you go to slide 17

706
00:30:57,409 --> 00:30:53,220
um one of those fascinating and under

707
00:30:59,750 --> 00:30:57,419
explored words are these icy moons of

708
00:31:02,090 --> 00:30:59,760
gas giants you know around Jupiter

709
00:31:05,269 --> 00:31:02,100
Saturn Uranus and Neptune there are many

710
00:31:09,049 --> 00:31:05,279
moons you know mostly made of ice all

711
00:31:11,630 --> 00:31:09,059
covered by Ice uh Europa garment

712
00:31:13,310 --> 00:31:11,640
Callisto Titan Trident so those are just

713
00:31:16,029 --> 00:31:13,320

a few examples

714
00:31:18,590 --> 00:31:16,039
um they are fascinating because

715
00:31:21,470 --> 00:31:18,600
many of them

716
00:31:24,070 --> 00:31:21,480
uh would likely you know not all of them

717
00:31:27,409 --> 00:31:24,080
probably but some of them have

718
00:31:30,950 --> 00:31:27,419
subsurface ocean there are liquid water

719
00:31:32,389 --> 00:31:30,960
ocean right below this thick shell of

720
00:31:34,990 --> 00:31:32,399
ice

721
00:31:39,610 --> 00:31:35,000
um likely illopad likely

722
00:31:41,570 --> 00:31:39,620
maybe on Thailand maybe on other moods

723
00:31:46,750 --> 00:31:41,580
and

724
00:31:49,610 --> 00:31:46,760
some of them you know are considered

725
00:31:52,490 --> 00:31:49,620
potentially habitable you know yeah no

726
00:31:55,370 --> 00:31:52,500
one knows if you know life can live

727
00:31:58,190 --> 00:31:55,380
there if it's there or not but you know

728
00:32:00,769 --> 00:31:58,200
uh sometimes it's suspect that these

729
00:32:01,850 --> 00:32:00,779
oceans could be habitable

730
00:32:06,049 --> 00:32:01,860
um

731
00:32:07,549 --> 00:32:06,059
among these icy Wars one of the uh Most

732
00:32:11,149 --> 00:32:07,559
Fascinating world

733
00:32:14,830 --> 00:32:11,159
s is in service can you go to the next

734
00:32:22,490 --> 00:32:19,250
this is a a relatively small moon of

735
00:32:25,730 --> 00:32:22,500
Saturn it's about 50

736
00:32:28,789 --> 00:32:25,740
or 500 kilometers across the surface

737
00:32:31,610 --> 00:32:28,799
area is around about Texas

738
00:32:35,029 --> 00:32:31,620

um so what makes this world unique is

739
00:32:39,590 --> 00:32:35,039
this geysers you know found by Cassini

740
00:32:42,409 --> 00:32:39,600
when it flew near the South Pole of this

741
00:32:47,149 --> 00:32:42,419
Moon it found that something was

742
00:32:50,409 --> 00:32:47,159
splashing out of this moon to space

743
00:32:52,909 --> 00:32:50,419
it turned out that this is a water vapor

744
00:32:56,630 --> 00:32:52,919
likely coming out from the subsurface

745
00:32:58,610 --> 00:32:56,640
ocean meaning that there are cracks you

746
00:33:00,529 --> 00:32:58,620
know in ice shell there are some conduit

747
00:33:03,409 --> 00:33:00,539
or crevice I don't know what it is no

748
00:33:06,590 --> 00:33:03,419
one know what exactly it is but

749
00:33:09,409 --> 00:33:06,600
there is a mechanism pathway that water

750
00:33:11,930 --> 00:33:09,419
comes out from the interior of this moon

751
00:33:15,230 --> 00:33:11,940
to the space and actually this water

752
00:33:19,490 --> 00:33:15,240
vapor forms one of the wings of Saturn

753
00:33:22,130 --> 00:33:19,500
so you know it's fascinating in many

754
00:33:27,110 --> 00:33:22,140
ways right you know but one reason is

755
00:33:30,610 --> 00:33:27,120
that hey this could be you know a a a a

756
00:33:33,830 --> 00:33:30,620
a a a a great pathway for us

757
00:33:35,810 --> 00:33:33,840
uh through which we can exploit you know

758
00:33:38,029 --> 00:33:35,820
let's explore more with uh with the next

759
00:33:40,730 --> 00:33:38,039
slide said 19.

760
00:33:42,590 --> 00:33:40,740
this is you know uh what scientists

761
00:33:44,990 --> 00:33:42,600
imagine the interior of the moon is

762
00:33:48,350 --> 00:33:45,000
again as I said you know there's a shell

763
00:33:52,669 --> 00:33:48,360

of ice below which there is likely a

764
00:33:56,149 --> 00:33:52,679
liquid ocean and around South Pole there

765
00:34:00,049 --> 00:33:56,159
is Conduit you know geysers so we

766
00:34:04,269 --> 00:34:00,059
thought you know can we make a tiny

767
00:34:07,669 --> 00:34:04,279
robot that can dive into these conduit

768
00:34:11,990 --> 00:34:07,679
goes down all the way to the ocean and

769
00:34:13,609 --> 00:34:12,000
possibly you know a mid life if there's

770
00:34:18,050 --> 00:34:13,619
any

771
00:34:18,829 --> 00:34:18,060
um so can you go to next slide please

772
00:34:23,589 --> 00:34:18,839
um

773
00:34:27,710 --> 00:34:23,599
some years ago uh in 2016 my colleague

774
00:34:30,109 --> 00:34:27,720
my friends and I got this you know a

775
00:34:33,710 --> 00:34:30,119
really small funding from a program

776
00:34:35,450 --> 00:34:33,720
called Nayak NASA's Innovative Advanced

777
00:34:39,109 --> 00:34:35,460
concept program

778
00:34:42,050 --> 00:34:39,119
to take a closer look about this

779
00:34:45,470 --> 00:34:42,060
seemingly crazy idea of sending robot

780
00:34:48,889 --> 00:34:45,480
down to this uh you know act events and

781
00:34:49,550 --> 00:34:48,899
studied if it is ever possible or not

782
00:34:52,250 --> 00:34:49,560
um

783
00:34:54,649 --> 00:34:52,260
uh skipping all the way to the

784
00:34:56,570 --> 00:34:54,659
conclusion we found that you know of

785
00:34:58,910 --> 00:34:56,580
course no one knows how it looks like

786
00:35:00,650 --> 00:34:58,920
below the surface of inside us there

787
00:35:03,349 --> 00:35:00,660
could be you know infinite number of

788
00:35:05,510 --> 00:35:03,359

possibilities but you know there are two

789
00:35:07,070 --> 00:35:05,520
silver roughly speaking you know there

790
00:35:08,930 --> 00:35:07,080
could the reality could be more complex

791
00:35:10,730 --> 00:35:08,940
than this one but civil roughly speaking

792
00:35:13,190 --> 00:35:10,740
there are two possibilities one is that

793
00:35:16,190 --> 00:35:13,200
you know that this event is uh you know

794
00:35:19,069 --> 00:35:16,200
wide open there's a clean interface of

795
00:35:21,170 --> 00:35:19,079
the water from which the water boils or

796
00:35:22,310 --> 00:35:21,180
somewhere somehow exfoliated and goes to

797
00:35:25,810 --> 00:35:22,320
go to space

798
00:35:28,430 --> 00:35:25,820
the other possibility is uh called

799
00:35:30,829 --> 00:35:28,440
cryovolcanic Model it's basically

800
00:35:33,170 --> 00:35:30,839
inverted rocket nozzle you know the high

801
00:35:35,210 --> 00:35:33,180
pressure liquid gas mixture goes up the

802
00:35:36,770 --> 00:35:35,220
vent and gas expands that propels the

803
00:35:39,950 --> 00:35:36,780
the jet

804
00:35:42,770 --> 00:35:39,960
um we found that this idea of going

805
00:35:45,170 --> 00:35:42,780
letting the robot going down the vent is

806
00:35:47,990 --> 00:35:45,180
likely possible likely feasible for open

807
00:35:51,410 --> 00:35:48,000
quality model uh it would be possible

808
00:35:54,170 --> 00:35:51,420
for cryovolcanic model it is harder but

809
00:35:57,770 --> 00:35:54,180
if the event size is more than 10

810
00:36:00,530 --> 00:35:57,780
centimeters which can be guaranteed but

811
00:36:03,170 --> 00:36:00,540
given that there are there seems to be

812
00:36:06,170 --> 00:36:03,180
more than hundreds of event openings

813
00:36:08,030 --> 00:36:06,180

what's the challenge that we can find at

814
00:36:09,890 --> 00:36:08,040
least one event that is more obtained

815
00:36:12,109 --> 00:36:09,900
with us the purpose is you know quite

816
00:36:14,810 --> 00:36:12,119
likely

817
00:36:16,910 --> 00:36:14,820
um yeah so you know you can go to the

818
00:36:19,609 --> 00:36:16,920
next slides please

819
00:36:22,430 --> 00:36:19,619
um yeah we you know do some experiments

820
00:36:26,210 --> 00:36:22,440
in the walking freezer and also the

821
00:36:29,930 --> 00:36:26,220
slide we run some cfd computational

822
00:36:33,530 --> 00:36:29,940
fluid dynamics and then we arrived

823
00:36:36,530 --> 00:36:33,540
um uh this uh robot can you go to slide

824
00:36:41,210 --> 00:36:40,609
yeah one more we uh you know

825
00:36:43,790 --> 00:36:41,220
um

826
00:36:46,250 --> 00:36:43,800
I felt okay so this could be one way to

827
00:36:48,650 --> 00:36:46,260
make this happen a tiny robot maybe you

828
00:36:51,829 --> 00:36:48,660
know again 10 centimeter in which is

829
00:36:54,770 --> 00:36:51,839
maybe uh 30 feet later in length you

830
00:36:57,410 --> 00:36:54,780
know has a few limbs uh at the end there

831
00:37:00,410 --> 00:36:57,420
are ice views to stick to the wall so

832
00:37:03,410 --> 00:37:00,420
it's not blown away you know uh maybe

833
00:37:06,530 --> 00:37:03,420
it's gonna crawl out of the van that and

834
00:37:09,290 --> 00:37:06,540
moves to the event and go down of course

835
00:37:11,270 --> 00:37:09,300
you know this is not the you know a

836
00:37:13,370 --> 00:37:11,280
design robot this is one of many

837
00:37:15,470 --> 00:37:13,380
possible designs and you know we are

838
00:37:18,349 --> 00:37:15,480

actively exploring you know more

839
00:37:22,250 --> 00:37:18,359
promising designs

840
00:37:25,490 --> 00:37:22,260
um but yeah so you know this could be

841
00:37:27,829 --> 00:37:25,500
um a fascinating uh you know idea and

842
00:37:30,829 --> 00:37:27,839
then you know of course this robot is

843
00:37:34,849 --> 00:37:30,839
going to you know go

844
00:37:36,530 --> 00:37:34,859
um into this event uh which is which has

845
00:37:38,870 --> 00:37:36,540
so many unknowns

846
00:37:41,210 --> 00:37:38,880
right you know you cannot fly your

847
00:37:44,210 --> 00:37:41,220
spacecraft above it and you know make a

848
00:37:46,609 --> 00:37:44,220
detailed map so you know

849
00:37:49,550 --> 00:37:46,619
um it has to deal with uncertainty it

850
00:37:52,849 --> 00:37:49,560
has to move vertically you have to

851
00:37:56,270 --> 00:37:52,859
control this complex robot to do so and

852
00:37:58,130 --> 00:37:56,280
also the environment is dynamic so there

853
00:38:01,849 --> 00:37:58,140
are so many reasons that this robot has

854
00:38:05,089 --> 00:38:01,859
to be again highly intelligent

855
00:38:07,490 --> 00:38:05,099
so hero I want to jump forward

856
00:38:10,130 --> 00:38:07,500
and loop back

857
00:38:13,250 --> 00:38:10,140
um I want to talk about Voyager again

858
00:38:15,470 --> 00:38:13,260
and talk about autonomy and something

859
00:38:18,050 --> 00:38:15,480
like this and if we go to our next image

860
00:38:19,130 --> 00:38:18,060
you can truly see how alone it is out

861
00:38:19,670 --> 00:38:19,140
there

862
00:38:21,530 --> 00:38:19,680
um

863
00:38:22,849 --> 00:38:21,540

talk to me about something like this and

864
00:38:26,150 --> 00:38:22,859
what is

865
00:38:28,430 --> 00:38:26,160
truly after you being here for 34 or

866
00:38:31,030 --> 00:38:28,440
like 34 years after this and all these

867
00:38:33,109 --> 00:38:31,040
great things talk to me about that

868
00:38:34,250 --> 00:38:33,119
yeah you know

869
00:38:36,530 --> 00:38:34,260
um

870
00:38:38,089 --> 00:38:36,540
it's amazing right it's fascinating that

871
00:38:40,430 --> 00:38:38,099
this spacecraft

872
00:38:41,630 --> 00:38:40,440
it keeps flying after a happy four years

873
00:38:44,329 --> 00:38:41,640
you know

874
00:38:46,370 --> 00:38:44,339
um when I was inspired right still

875
00:38:48,410 --> 00:38:46,380
flying beyond the heliopath you know

876
00:38:49,910 --> 00:38:48,420
into the in the cell space

877
00:38:50,569 --> 00:38:49,920
um you know

878
00:38:53,089 --> 00:38:50,579
um

879
00:38:56,030 --> 00:38:53,099
and and interesting interestingly

880
00:38:59,690 --> 00:38:56,040
there's no other spacecraft still that

881
00:39:03,290 --> 00:38:59,700
you know went beyond you know were

882
00:39:06,109 --> 00:39:03,300
apologize right but you know surely

883
00:39:08,829 --> 00:39:06,119
someday you know we should catch up and

884
00:39:11,870 --> 00:39:08,839
move Beyond right you know we gonna

885
00:39:14,510 --> 00:39:11,880
explore the icy moons of

886
00:39:16,130 --> 00:39:14,520
as Giants someday will go to the

887
00:39:19,490 --> 00:39:16,140
subsurface ocean we're going to probably

888
00:39:21,050 --> 00:39:19,500

go back to Neptune system someday in

889
00:39:24,530 --> 00:39:21,060
particular it's Moon Trident which is

890
00:39:26,510 --> 00:39:24,540
very interesting maybe kbos you know we

891
00:39:28,569 --> 00:39:26,520
know there are many Pluto sized dwarf

892
00:39:31,430 --> 00:39:28,579
planets beyond the orbit of Neptune

893
00:39:33,650 --> 00:39:31,440
eventually maybe intercept space right

894
00:39:36,829 --> 00:39:33,660
you know like chop it one system which

895
00:39:38,030 --> 00:39:36,839
has multiple habitable planets which may

896
00:39:41,510 --> 00:39:38,040
take

897
00:39:45,890 --> 00:39:41,520
you know uh hundreds of a thousands of

898
00:39:48,230 --> 00:39:45,900
years to get there maybe you know um

899
00:39:49,370 --> 00:39:48,240
yeah so you know thinking about Voyager

900
00:39:50,390 --> 00:39:49,380
right

901
00:39:54,410 --> 00:39:50,400
um

902
00:39:59,390 --> 00:39:54,420
you know uh it only happened sometimes

903
00:40:01,910 --> 00:39:59,400
um after a success was made uh you know

904
00:40:02,990 --> 00:40:01,920
we often kind of take it granted right

905
00:40:06,050 --> 00:40:03,000
you know

906
00:40:10,670 --> 00:40:06,060
um it's hard to imagine how Innovative

907
00:40:13,730 --> 00:40:10,680
it was uh but if you put yourself for

908
00:40:16,970 --> 00:40:13,740
the Viewpoint of the past this uh idea

909
00:40:20,270 --> 00:40:16,980
of grand tour right you know uh visiting

910
00:40:22,370 --> 00:40:20,280
four major planets gastrian planets in

911
00:40:23,630 --> 00:40:22,380
one Mission which basically what Voyager

912
00:40:26,750 --> 00:40:23,640
tilted

913
00:40:29,569 --> 00:40:26,760

was initially conceived in 1965 by this

914
00:40:33,290 --> 00:40:29,579
graduate student named Gary flandro and

915
00:40:35,630 --> 00:40:33,300
that time 1965 what JPL did and what

916
00:40:37,849 --> 00:40:35,640
whole world did actually was to send

917
00:40:40,069 --> 00:40:37,859
only two spacecrafts successfully to

918
00:40:42,770 --> 00:40:40,079
other planets right one to Venus one to

919
00:40:44,390 --> 00:40:42,780
Mars and you know that time you know

920
00:40:47,030 --> 00:40:44,400
this guy was talking about creating a

921
00:40:49,670 --> 00:40:47,040
spacecraft that that last tens of years

922
00:40:51,410 --> 00:40:49,680
and going all the way to Uranus and

923
00:40:52,430 --> 00:40:51,420
Neptune and eventually to industrial

924
00:40:54,890 --> 00:40:52,440
space

925
00:40:57,290 --> 00:40:54,900
what you're talking about right you know

926
00:40:59,510 --> 00:40:57,300
um that was the craziest idea at the

927
00:41:01,910 --> 00:40:59,520
time if no one believed it laughed at it

928
00:41:04,130 --> 00:41:01,920
but you know but it happened eventually

929
00:41:05,470 --> 00:41:04,140
you know JPL made it happen

930
00:41:10,430 --> 00:41:05,480
so

931
00:41:13,089 --> 00:41:10,440
Voya reminds me reminds us that you know

932
00:41:17,390 --> 00:41:13,099
JPL is a place where

933
00:41:19,849 --> 00:41:17,400
grown-ups are allowed to dream big

934
00:41:25,910 --> 00:41:19,859
right you know and it's a place where

935
00:41:31,370 --> 00:41:29,569
with that reality before we started this

936
00:41:33,530 --> 00:41:31,380
talk you were holding your child in your

937
00:41:36,170 --> 00:41:33,540
arms while you were setting up yeah

938
00:41:38,450 --> 00:41:36,180

um how

939
00:41:40,670 --> 00:41:38,460
when you look at this and look for

940
00:41:42,290 --> 00:41:40,680
what's next not just for this Mission

941
00:41:46,970 --> 00:41:42,300
but for all these missions but for also

942
00:41:53,930 --> 00:41:51,109
yeah you know I mean like life needs

943
00:41:55,790 --> 00:41:53,940
them my my personal life hey I guess

944
00:41:57,950 --> 00:41:55,800
yeah I mean I can hear it around you too

945
00:41:59,870 --> 00:41:57,960
I can hear it right now live

946
00:42:01,910 --> 00:41:59,880
it's a very exciting life you got yeah

947
00:42:04,430 --> 00:42:01,920
yeah so

948
00:42:05,750 --> 00:42:04,440
um why don't you show me the last slide

949
00:42:08,690 --> 00:42:05,760
um

950
00:42:12,230 --> 00:42:08,700
yeah that was actually the last weekend

951
00:42:15,230 --> 00:42:12,240
you know uh the Jupiter and vidas were

952
00:42:17,990 --> 00:42:15,240
at conjunctions so you know I

953
00:42:21,050 --> 00:42:18,000
you know I took my daughter to the front

954
00:42:22,970 --> 00:42:21,060
yard and you know pull that tennis club

955
00:42:26,210 --> 00:42:22,980
from the garage and you know the

956
00:42:29,569 --> 00:42:26,220
performance we I'm still kidding Stars

957
00:42:31,670 --> 00:42:29,579
you know after 35 years when my father

958
00:42:33,410 --> 00:42:31,680
gave me this telescope you know not with

959
00:42:36,170 --> 00:42:33,420
my father anymore you know with my kids

960
00:42:38,089 --> 00:42:36,180
you know I like this I like this a lot

961
00:42:40,250 --> 00:42:38,099
to getting Stars still

962
00:42:43,130 --> 00:42:40,260
um I think for two reasons right one is

963
00:42:44,870 --> 00:42:43,140

that you know yeah I said JP is a place

964
00:42:46,970 --> 00:42:44,880
where we can drink big but of course you

965
00:42:49,730 --> 00:42:46,980
know we are not you know thinking about

966
00:42:52,310 --> 00:42:49,740
big things 40 hours per per week every

967
00:42:54,650 --> 00:42:52,320
day right there's so many you know

968
00:42:57,290 --> 00:42:54,660
little things to border right you know

969
00:43:00,770 --> 00:42:57,300
just like any other workplace you know

970
00:43:02,630 --> 00:43:00,780
um hey this thing bro it was broken you

971
00:43:04,490 --> 00:43:02,640
know we have to be fixed a bag

972
00:43:06,410 --> 00:43:04,500
you know we are running on funding you

973
00:43:07,569 --> 00:43:06,420
know we have to keep our stakeholders

974
00:43:10,210 --> 00:43:07,579
happy

975
00:43:14,329 --> 00:43:10,220
they're so you know many little things

976
00:43:16,370 --> 00:43:14,339
but you know uh if I go out in the night

977
00:43:18,290 --> 00:43:16,380
and get Stars you know that kind of let

978
00:43:22,490 --> 00:43:18,300
me forget about those little you know

979
00:43:24,829 --> 00:43:22,500
things and you know uh reminds reminds

980
00:43:27,589 --> 00:43:24,839
me why I'm doing this job you know where

981
00:43:29,690 --> 00:43:27,599
I started uh what's my big dream was has

982
00:43:32,390 --> 00:43:29,700
been right and of course you know it's

983
00:43:34,790 --> 00:43:32,400
also you know for my daughter right to

984
00:43:37,910 --> 00:43:34,800
inspire my kids you know like my father

985
00:43:41,210 --> 00:43:37,920
did for me my like Voyage of it for me

986
00:43:43,490 --> 00:43:41,220
you know we you know work hard to you

987
00:43:45,890 --> 00:43:43,500
know make our big dreams come true you

988
00:43:48,109 --> 00:43:45,900

know which inspires the the Next

989
00:43:51,050 --> 00:43:48,119
Generation like my kids so that they can

990
00:43:52,970 --> 00:43:51,060
even have bigger dreams and when they

991
00:43:54,890 --> 00:43:52,980
grow up you know perhaps they're gonna

992
00:43:57,710 --> 00:43:54,900
you know work on their own dream and

993
00:43:59,030 --> 00:43:57,720
that's that's the way that humans make

994
00:44:03,109 --> 00:43:59,040
progress

995
00:44:05,270 --> 00:44:03,119
thank you so much hero there have been a

996
00:44:06,950 --> 00:44:05,280
lot of great questions out there on the

997
00:44:09,050 --> 00:44:06,960
on all the platforms so I'm gonna throw

998
00:44:21,950 --> 00:44:09,060
it back over to Rachel how's it going

999
00:44:25,490 --> 00:44:23,809
I'd like to see how many I can get

1000
00:44:27,349 --> 00:44:25,500
through so yeah

1001
00:44:29,930 --> 00:44:27,359
um there's so many amazing questions

1002
00:44:32,569 --> 00:44:29,940
Rachel can I interrupt you for a second

1003
00:44:34,309 --> 00:44:32,579
uh your your audio is getting a little

1004
00:44:36,290 --> 00:44:34,319
fuzzy right now so I'll ask the first

1005
00:44:37,910 --> 00:44:36,300
one that you've highlighted for me if

1006
00:44:39,890 --> 00:44:37,920
you want to reload and we can ask that

1007
00:44:42,530 --> 00:44:39,900
back in

1008
00:44:44,630 --> 00:44:42,540
um so actually on LinkedIn wants to know

1009
00:44:46,550 --> 00:44:44,640
did you find any differences or

1010
00:44:48,650 --> 00:44:46,560
surprises in training perseverance as

1011
00:44:51,770 --> 00:44:48,660
autonav on Earth and when it started

1012
00:44:54,890 --> 00:44:53,390
good question

1013
00:44:58,010 --> 00:44:54,900

um

1014
00:45:01,309 --> 00:44:58,020
yeah maybe the biggest surprise is that

1015
00:45:02,329 --> 00:45:01,319
it works so well you know

1016
00:45:07,490 --> 00:45:02,339
um

1017
00:45:11,089 --> 00:45:07,500
the autodev

1018
00:45:14,210 --> 00:45:11,099
uh you know my worry was that you know

1019
00:45:17,030 --> 00:45:14,220
what if my cause my what if I called

1020
00:45:20,329 --> 00:45:17,040
crashes this you know multi-made without

1021
00:45:21,490 --> 00:45:20,339
a Rover you know uh but it hasn't

1022
00:45:26,150 --> 00:45:21,500
happened

1023
00:45:29,510 --> 00:45:26,160
it works so well you know so yeah maybe

1024
00:45:32,750 --> 00:45:29,520
that's a positive surprise that I had

1025
00:45:36,349 --> 00:45:32,760
very cool Rich are you back with us

1026
00:45:37,370 --> 00:45:36,359
I hope so am I bad yes I'm great welcome

1027
00:45:40,130 --> 00:45:37,380
back

1028
00:45:42,470 --> 00:45:40,140
okay thank you sorry everyone out there

1029
00:45:43,609 --> 00:45:42,480
for the audio issue but I'm glad to be

1030
00:45:47,870 --> 00:45:43,619
back

1031
00:45:51,109 --> 00:45:47,880
um okay so mace Bob on YouTube asks to

1032
00:45:53,870 --> 00:45:51,119
you hero do you think we're close to a

1033
00:45:56,030 --> 00:45:53,880
robot being able to decide to pursue

1034
00:45:59,329 --> 00:45:56,040
discoveries that the mission planners

1035
00:46:02,150 --> 00:45:59,339
were unable to identify

1036
00:46:05,089 --> 00:46:02,160
um unfortunately we are far from it um

1037
00:46:07,970 --> 00:46:05,099
in my opinion you know uh yes

1038
00:46:10,069 --> 00:46:07,980

um article indigenous made a really

1039
00:46:11,809 --> 00:46:10,079
impressive progress in the past uh you

1040
00:46:13,670 --> 00:46:11,819
know I guess I dig it ourselves everyone

1041
00:46:17,650 --> 00:46:13,680
knows about it you know there are so so

1042
00:46:19,849 --> 00:46:17,660
much news about Chachi PT for example

1043
00:46:21,290 --> 00:46:19,859
but you know

1044
00:46:27,530 --> 00:46:21,300
um

1045
00:46:29,569 --> 00:46:27,540
well as long as it's inputs and outputs

1046
00:46:33,290 --> 00:46:29,579
are confined within computer system from

1047
00:46:36,470 --> 00:46:33,300
the network but you know when you know

1048
00:46:38,829 --> 00:46:36,480
it has to handle the real world you know

1049
00:46:41,930 --> 00:46:38,839
you have to handle physical interaction

1050
00:46:43,250 --> 00:46:41,940
it's still way behind for example you

1051
00:46:44,809 --> 00:46:43,260
know I'm a Japanese so you know I can

1052
00:46:48,069 --> 00:46:44,819
easily pick up tofu with chopsticks

1053
00:46:50,990 --> 00:46:48,079
right that's a very hard task for robots

1054
00:46:53,569 --> 00:46:51,000
uh you know picking a brows featuring a

1055
00:46:54,170 --> 00:46:53,579
haul so you know

1056
00:46:59,210 --> 00:46:54,180
um

1057
00:47:01,210 --> 00:46:59,220
I don't believe that AI or you know or

1058
00:47:03,170 --> 00:47:01,220
autonomy going to take over humans

1059
00:47:06,710 --> 00:47:03,180
particularly Interiors physical

1060
00:47:11,510 --> 00:47:06,720
interaction and creativity so you know

1061
00:47:14,870 --> 00:47:11,520
uh it's still far from the time when AI

1062
00:47:16,250 --> 00:47:14,880
replaced our scientists in my opinion uh

1063
00:47:19,490 --> 00:47:16,260

but you know

1064
00:47:22,190 --> 00:47:19,500
um AI is our helpful friends and as it

1065
00:47:24,109 --> 00:47:22,200
gets more and more killable if it can do

1066
00:47:27,470 --> 00:47:24,119
just you know one tenth of what humans

1067
00:47:31,190 --> 00:47:27,480
can do we can just move Way Beyond

1068
00:47:32,630 --> 00:47:31,200
yeah a wonderful answer hero so

1069
00:47:36,589 --> 00:47:32,640
um we have time for two more questions

1070
00:47:39,530 --> 00:47:36,599
uh but on that on a similar note

1071
00:47:42,170 --> 00:47:39,540
um and I I really like this one just

1072
00:47:44,990 --> 00:47:42,180
well you'll see why Josh on YouTube asks

1073
00:47:47,809 --> 00:47:45,000
how often is human input needed by the

1074
00:47:49,849 --> 00:47:47,819
autonomous robots

1075
00:47:53,510 --> 00:47:49,859
um it really depends

1076
00:47:56,510 --> 00:47:53,520
um depends on the type of the

1077
00:47:58,970 --> 00:47:56,520
um algorithm you make you know learning

1078
00:48:00,530 --> 00:47:58,980
is not the only way right uh

1079
00:48:03,290 --> 00:48:00,540
conventional

1080
00:48:07,010 --> 00:48:03,300
um autonomy algorithms you know uh you

1081
00:48:09,370 --> 00:48:07,020
can call it a classical AI is basically

1082
00:48:11,990 --> 00:48:09,380
something that human Engineers design

1083
00:48:13,670 --> 00:48:12,000
right instead of uh you know let it

1084
00:48:17,270 --> 00:48:13,680
learn by itself right

1085
00:48:20,030 --> 00:48:17,280
um so Engineers design how it gonna

1086
00:48:21,410 --> 00:48:20,040
behave and you turned on then it get it

1087
00:48:23,210 --> 00:48:21,420
keeps going

1088
00:48:25,210 --> 00:48:23,220

right

1089
00:48:28,250 --> 00:48:25,220
um there are you know learning

1090
00:48:31,190 --> 00:48:28,260
algorithms there are algorithms that

1091
00:48:33,849 --> 00:48:31,200
needs to be supervised you know that

1092
00:48:37,970 --> 00:48:33,859
means you know examples to be trained

1093
00:48:42,050 --> 00:48:37,980
there are algorithms that can self-train

1094
00:48:44,990 --> 00:48:42,060
you know uh it can teach itself uh there

1095
00:48:47,569 --> 00:48:45,000
are algorithms you know it gets feedback

1096
00:48:49,970 --> 00:48:47,579
from people you know uh like teacher

1097
00:48:52,370 --> 00:48:49,980
students you know students you know do

1098
00:48:54,589 --> 00:48:52,380
some work and teachers gives feedback

1099
00:48:56,809 --> 00:48:54,599
and you know um so there are many

1100
00:48:58,490 --> 00:48:56,819
different ways so I cannot we cannot say

1101
00:49:01,370 --> 00:48:58,500
you know

1102
00:49:03,650 --> 00:49:01,380
um I don't give a simple answer but it

1103
00:49:06,890 --> 00:49:03,660
depends

1104
00:49:08,930 --> 00:49:06,900
understood understood okay last question

1105
00:49:11,510 --> 00:49:08,940
I'm sorry to not get to all of your

1106
00:49:13,790 --> 00:49:11,520
questions they are actually amazing so

1107
00:49:15,109 --> 00:49:13,800
I'm hoping we can send all of these over

1108
00:49:16,790 --> 00:49:15,119
to Hero

1109
00:49:19,190 --> 00:49:16,800
um just so he knows what's on here I

1110
00:49:20,690 --> 00:49:19,200
spoke too much I should have no you

1111
00:49:23,450 --> 00:49:20,700
didn't oh this book just the right

1112
00:49:27,170 --> 00:49:23,990
um

1113
00:49:28,790 --> 00:49:27,180

this one yeah this one I'm very excited

1114
00:49:31,130 --> 00:49:28,800
to ask so what is one of your favorite

1115
00:49:36,589 --> 00:49:31,140
moments that you've experienced of our

1116
00:49:40,849 --> 00:49:39,290
oh

1117
00:49:43,370 --> 00:49:40,859
it's a good one the question was what's

1118
00:49:46,370 --> 00:49:43,380
my what's the best moment

1119
00:49:48,109 --> 00:49:46,380
yeah yeah essentially what's your

1120
00:49:50,750 --> 00:49:48,119
favorite moment right operating these

1121
00:49:54,470 --> 00:49:50,760
Rovers you've experienced something that

1122
00:49:56,569 --> 00:49:54,480
so few people get to experience

1123
00:49:59,630 --> 00:49:56,579
maybe you can think of one moment I'm

1124
00:50:02,270 --> 00:49:59,640
sure there's many though

1125
00:50:03,890 --> 00:50:02,280
yeah I think it's still that the landing

1126
00:50:06,530 --> 00:50:03,900
of perseverance you know the moment

1127
00:50:08,750 --> 00:50:06,540
because yeah you know it's not because I

1128
00:50:11,870 --> 00:50:08,760
was involved in landing that was not my

1129
00:50:14,630 --> 00:50:11,880
job but you know simply because you know

1130
00:50:17,150 --> 00:50:14,640
uh if it doesn't land well then you know

1131
00:50:18,170 --> 00:50:17,160
uh everything that I did before was you

1132
00:50:21,770 --> 00:50:18,180
know uh

1133
00:50:24,109 --> 00:50:21,780
go away right but also I don't know as a

1134
00:50:26,329 --> 00:50:24,119
team as a project you know hundreds

1135
00:50:29,089 --> 00:50:26,339
maybe thousands of people you know spend

1136
00:50:32,390 --> 00:50:29,099
so many years to you know make this

1137
00:50:34,430 --> 00:50:32,400
happen and it hinged on this you know

1138
00:50:37,190 --> 00:50:34,440

seven minutes of Terror how this female

1139
00:50:40,970 --> 00:50:37,200
ultimate robot can do is shop by itself

1140
00:50:43,670 --> 00:50:40,980
and we were so anxiously watching it and

1141
00:50:46,849 --> 00:50:43,680
when this you know confirmation signal

1142
00:50:50,809 --> 00:50:46,859
came back from Mars we are on Mars that

1143
00:50:53,809 --> 00:50:50,819
was really uh you know moment for me

1144
00:50:56,690 --> 00:50:53,819
it's amazing uh on that note Brian yeah

1145
00:50:59,210 --> 00:50:56,700
I know you will close us out thank you

1146
00:51:00,710 --> 00:50:59,220
thank you no thank you both very much

1147
00:51:03,049 --> 00:51:00,720
that is all the time that we have for

1148
00:51:05,569 --> 00:51:03,059
tonight please join us in April when we

1149
00:51:06,950 --> 00:51:05,579
discuss Earth and the emit mission

1150
00:51:10,309 --> 00:51:06,960
I would personally like to thank

1151
00:51:13,670 --> 00:51:10,319
Christopher Colin Max Bill Corey Robert

1152
00:51:17,510 --> 00:51:13,680
Gabby Emily Rachel Mark Curtis Nikki

1153
00:51:19,190 --> 00:51:17,520
Amanda the Kims Joey and everyone

1154
00:51:20,870 --> 00:51:19,200
everyone behind the scenes who make

1155
00:51:22,609 --> 00:51:20,880
these public talks possible it truly

1156
00:51:24,650 --> 00:51:22,619
does take a team I would like to thank

1157
00:51:26,990 --> 00:51:24,660
our co-host Rachel and our speaker hero

1158
00:51:29,809 --> 00:51:27,000
for the passion expertise and general

1159
00:51:31,309 --> 00:51:29,819
awesomeness uh our final thank you is to

1160
00:51:34,250 --> 00:51:31,319
you the audience who join us every

1161
00:51:36,890 --> 00:51:34,260
single month this is your space program

1162
00:51:38,390 --> 00:51:36,900
and it is our honor to bring you these

1163
00:51:42,470 --> 00:51:38,400

monthly talks