Advanced IOT Applications
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Lecture -16
Range estimation & Obstacle avoidance

Folks let us now do some assignments on LiDAR, because it is a very important sensor for future automotive autonomous vehicles. The first assignment is I have written it down here in the below figure is to calculate the distance from the LiDAR to the side walls. So, you need a tool, for this you have to download the sweep visualizer tool.

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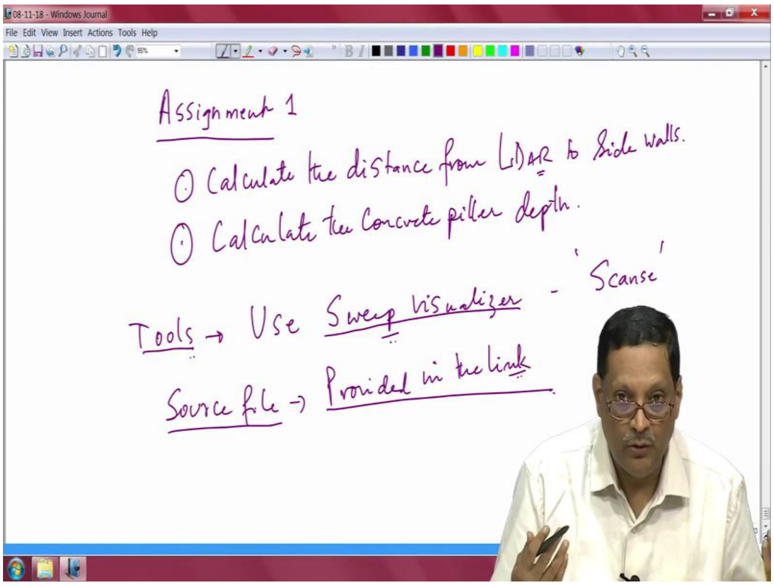

If you go to Scanse website, you can download the sweep visualizer tool from there freely and import a file, which file to import into because, you do not have a LiDAR with you need to import a file. This source file I will provide you on a link. You just get that source file into this sweep visualizer you will get back the environment that we are having here. And in this visualizer tool, because that is what will give you a feel of what you can do even without an expensive system like a LiDAR.

So, what is the current environment in which we are this is the recording studio. There is a wall on my left side, there is a wall and a door on my right side, there is a wall ahead of me and there is a screen color screen behind me. Let us take this recording studio itself as a nice environment where you want to make these measurements. So now, let me show you the LiDARs view of this room.

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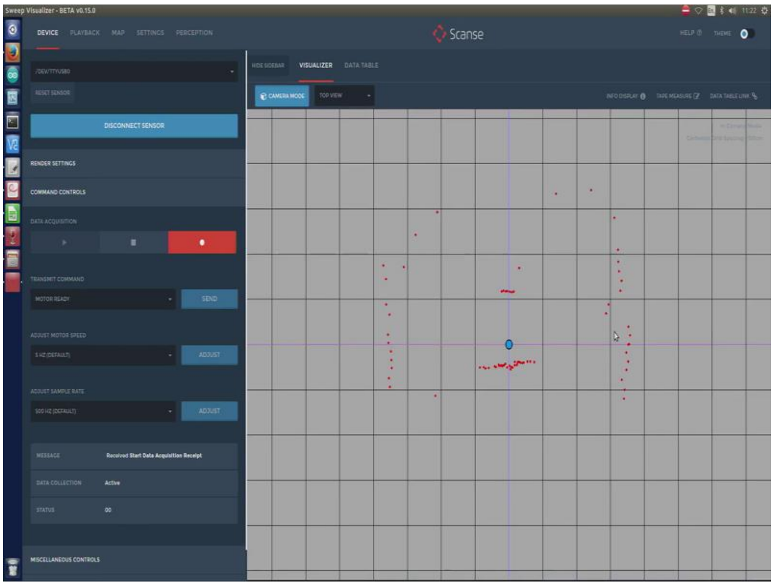

LiDAR is seeing a wall and other side another wall, but you see there is a nice extension or a protrusion for these LiDAR points. You will have to figure out what those protrusion points are and why is it protruded front.

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The protrusion indeed is the pillar, it is a pillar concrete pillar and my problem statement is, what is the width of this pillar? This picture is actually capturing everything that you need for completing this exercise. Visualizer points is showing you the wall, it is showing you the front obstruction densely populated LiDAR points and a chair which is just behind on the other side on which there is the other obstruction.

LiDAR is located exactly on the grid point. The distance between LiDAR and the table is 43 centimeters.

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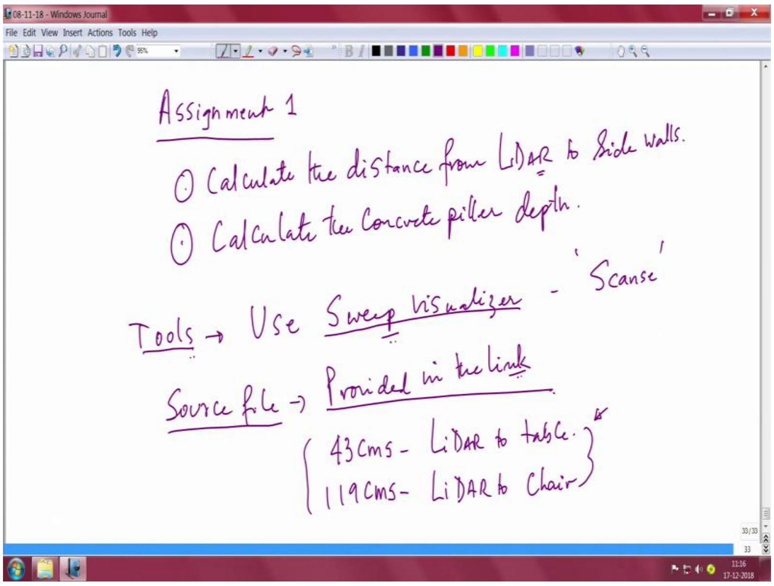

Now, let us look at the other chair obstacle, which is on the other side and that is 119 centimeters LiDAR to chair. The assignment is if you know the two distances, you will have to figure out the distance from LiDAR to sidewalls, you will also have to find out the concrete pillar depth. So, this indeed is the assignment.

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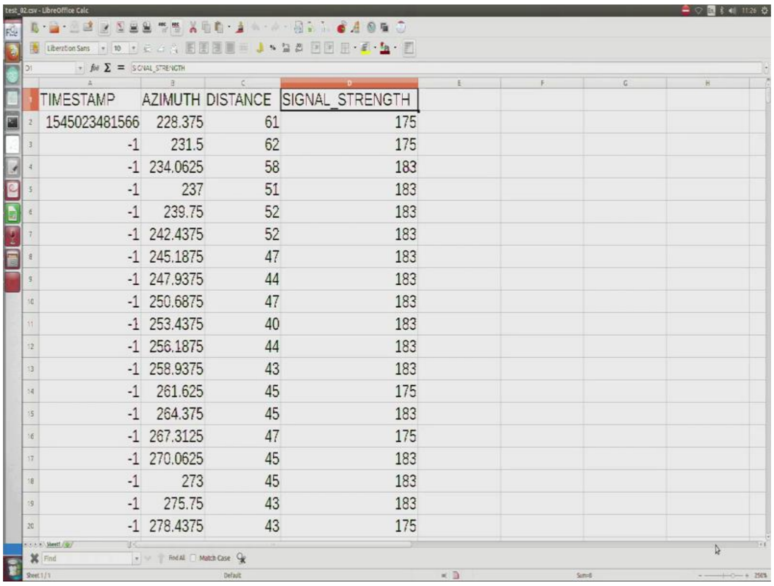

TIMESTAMP	AZIMUTH	DISTANCE	SIGNAL_STRENGTH
1545023481566	228.375	61	175
-1	231.5	62	175
-1	234.0625	58	183
-1	237	51	183
-1	239.75	52	183
-1	242.4375	52	183
-1	245.1875	47	183
-1	247.9375	44	183
-1	250.6875	47	183
-1	253.4375	40	183
-1	256.1875	44	183
-1	258.9375	43	183
-1	261.625	45	175
-1	264.375	45	183
-1	267.3125	47	175
-1	270.0625	45	183
-1	273	45	183
-1	275.75	43	183
-1	278.4375	43	175

Let us now see what is the information available from the sweep LiDAR system? If, you use the sweep visualizer, you will also see this figure shown above. If you want to know more about the packet format, the way this data is organized, please look up their manual.

The first column indeed is the timestamp, the second column is the azimuth which is essentially because, this is a 360 degree rotating LiDAR, you should know with respect to a standard reference point, which is indeed a LED light which is shown up on the LiDAR; you do not have to worry there is a reference point. With respect to that reference point 0, it is telling you that the angle is 228.375 degrees. It is telling you when the light packet leaves the transmitter and comes back, it is giving it is measuring a distance of 61 centimeters. And, it is also saying I can tell you that my signal strength is 175.

Signal strengths typically are from 0 to 255 and because this is an 8 bit number. So, 175 is a good signal strength. You will also see several points which are much lower than 175 may be 70 or 50.

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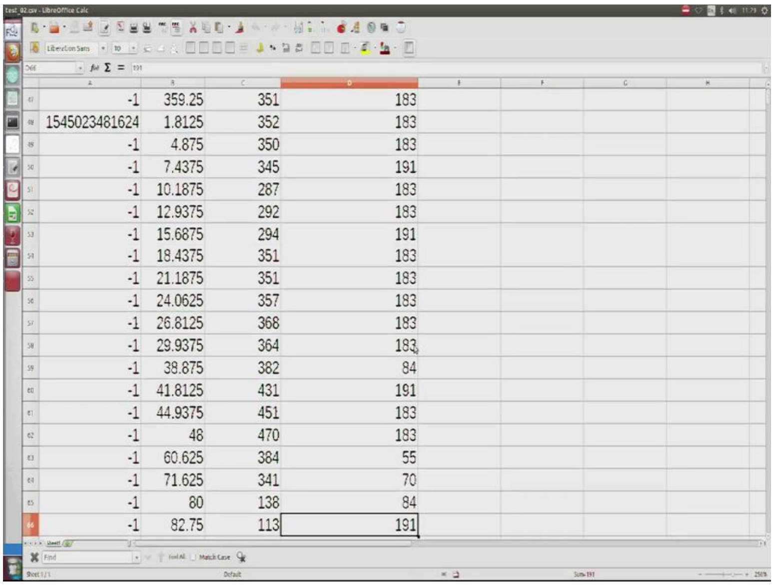

A	B	C	D
-1	359.25	351	183
1545023481624	1.8125	352	183
-1	4.875	350	183
-1	7.4375	345	191
-1	10.1875	287	183
-1	12.9375	292	183
-1	15.6875	294	191
-1	18.4375	351	183
-1	21.1875	351	183
-1	24.0625	357	183
-1	26.8125	368	183
-1	29.9375	364	183
-1	38.875	382	84
-1	41.8125	431	191
-1	44.9375	451	183
-1	48	470	183
-1	60.625	384	55
-1	71.625	341	70
-1	80	138	84
-1	82.75	113	191

We are going to look at that demo code I have just re-sketched everything back to explain to you exactly the demo that the LiDAR demonstration is all about look at this picture.

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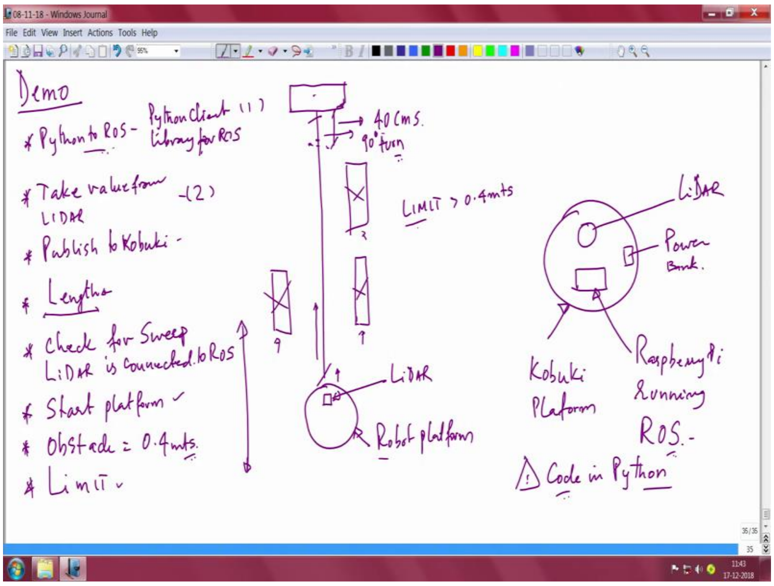

Here is a robotic platform and the LiDAR is mounted on top you have already seen that. And, there are obstacles on either side there is an obstacle in front.

The critical distance that we have set is 40 centimeters. If the distance is less than 40 centimeters; that means, it has just crossed here the robotic platform should turn and take a 90 degree turn; 90 degree turn this is the demo right. So, what does it mean? If you have to take a right turn, you have to instruct the robotic platform give trust to the wheels motors, which are couple to the wheels such that it turns to the right.

There is a LiDAR, there is a power bank, there is a Raspberry pi running open to and on that is running this middle wire called ROS, which is the Robot Operating System. And, there is a lot of Python code with which you interface run code in Python when you talk to ROS.

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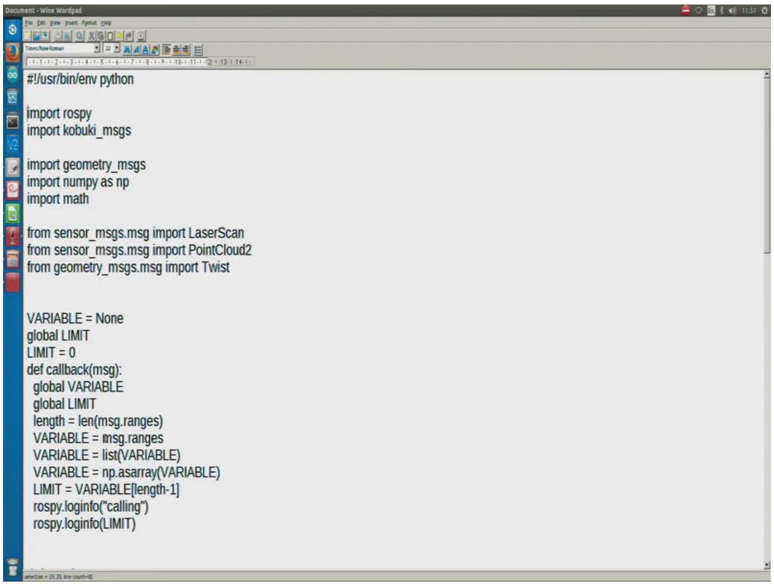

So, you have to initialize python to ROS, a Python client library for ROS. Second step is take value from LiDAR and initialize a variable called length. Then publish to Kobuki is also a part. Now, here the algorithm is pretty straight forward, you give you start the robotic platform and continuously estimate the limit variable. And, then you find out whether this limit variable is greater than this 0.4 meters. Limit if it is greater than 0.4 meters or 40 centimeters you are nothing to worry keep moving in the straight line; proceed till you get a point where soon you realize that limit indeed is less than 0.4 and there exactly you take a right turn. All of that is here you have to do some initializations to check if sweep is switched on and the LiDAR is connected to the ROS, you start the platform you find out whether there is an obstacle and use this limit variable to essentially make a distance to make a decision on turning the robotic platform. So, all of that is shown in this source code given.

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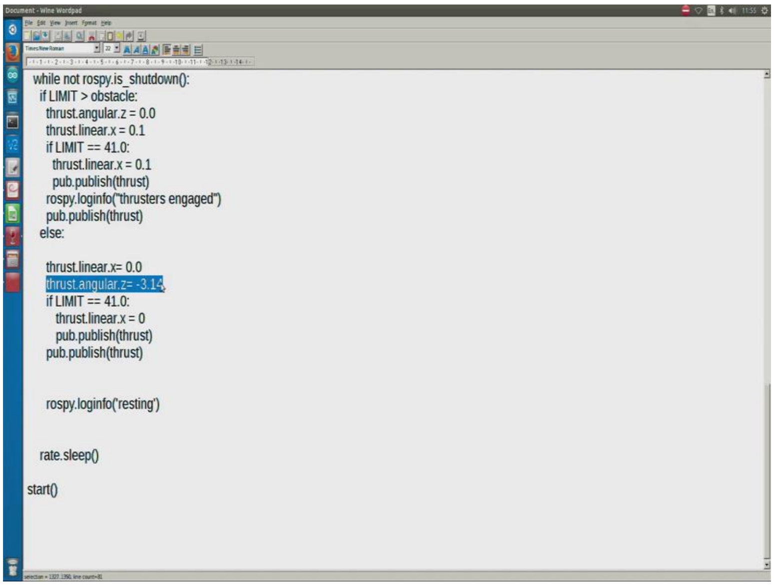

This is indeed an overview of what the demonstration using LiDAR which have shown to you.

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LiDARs view is 360 degree you have to ensure that what is not in the path of the LiDAR is you know is not really an obstacle. So, you have to also take care of that. So, the overall distance between the start of the LiDAR to the actual obstacle is a 240 centimeters, and moment it senses that limit it is expected to turn to the right and then start moving.

So, you might have seen this demonstration where exactly at the point where this tape indication in the above figure.

Why should we do such a harsh turn, in reality that is not going to happen? It is expected that you go round this object, you halt estimate the size of the object, and if the object indeed; the obstacle indeed is a very small one, and there is sufficient road space. Here you would expect that the robotic platform actually go-around the object.

So, it will be good for you to start looking at how to write a simple pseudo code, where if the starting point given to you is a turn to 90 degree. If, this is the code that is given to you could perhaps look at writing a nice pseudo code on how you would modify such a code to go round the object.

Thank you very much.