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**Analysis** **to pick correct range of circle location and size to ensure implementability**

This analysis is to know the correct range for the circle’s location and size to ensure that the robot draws a circle around or within the reachable workspace of the robot using or based the user’s input for latitude, longitude, and radius, and the circle should be within the reachable workspace of the robot. The workspace of the robot is the maximum reach or distance that the end effector can move from its base starting position. This range is important because it helps us know where the circle can be located and how large or small it can be while making sure that every point is within the robot reachable workspace and can be reached by the robot. To achieve this, the following factors need to be carefully considered:

**The workspace of our 6 DOF Robot:**

In our code, the robot's workspace is made to be a spherical volume, with a maximum reachable radius of **1 meter**. This means that the end-effector of the robot can only move within the sphere whose distance of radius to the center of the sphere is 1 meter. it must always remain within this sphere to be considered valid and any points beyond 1 meter distance from the robot’s origin is invalid and not in the robot reachable workspace. that the robot's end effector can only move within a sphere of radius 1 meter, centered at the

**Circle Definitions in our code (Latitude, Longitude and radius Input):**

In our code, we let the user provide the latitude, longitude and radius coordinates to define the center of the circle. Latitude in our code is the center of the circle along the X-axis, Longitude is the center of the circle along the Y-axis and the radius determines how far the points on the circle's boundary extend from its center or origin. So, . Therefore, ensure that both the center of the circle and the boundary are within the robot’s maximum reach or reachable workspace. Because if this condition is violated or not followed, the circle's radius or location is or becomes invalid. This is because the robot cannot physically reach the circle’s boundary, or the circle boundary is outside the robot reachable workspace. We know the formula of radius is calculated as for 2d version. But for 3d ,we need to account for the z dimension so the radius is calculated as . Here height is the vertical offset of the input point.

**How to check if the location of the circle and sizes of the circle are Valid:**

We know that the center of the circle must be within the robot’s maximum reachable radius, which is **1 meter** from the origin so the distance from the center should be less than or equal to 1 to ensure it is within the robot’s reachable workspace and it is reachable by the robot’s end effector. Now let us calculate point for longitude, latitude and radius that are within the robot reachable workspace. Let us assume the user input the points for the circle as **(latitude = 0.5, longitude = 0.5)** then the distance from the origin would be . So our radius will be 0.293. This is because and in our case it is . So, we subtract 0.707 from 1.0 and we have 0.293. If the user inputs any points bigger than 0.293 for radius, then it will be invalid. Let’s assume the point for longitude and latitude are the same point as above but the user input 0.3 as the radius then we will have = 0.707 + 0.3 = 1.0071 which is outside the maximum reach. Furthermore, if the user input the points for the circle as **(latitude = 1.3, longitude = 0)** then the distance from the origin would exceed the maximum reach which is 1 meter of the robot reachable workspace. Therefore, it would be invalid.

**How our code handles Large or Invalid Circles:**

The GUI and the function provide feedback and gives an error message to the user when an invalid circle is requested or points beyond reach are inputted to let them know the points input is invalid and not within the robot’s workspace. This includes:

* If the distance of the circle’s center exceeds the robot's maximum reach
* If the circle's radius is too large to be traced, given the position of the center.

**Summary of valid ranges for circle location and sizes:**

The valid range for the circle’s center and sizes must follow these conditions:

* The center must be within 1 meter from the origin. Therefore, the
* The radius must be in a way that the farthest point on the circle does not exceed the robot’s maximum reach. Therefore, . This makes sure that the farthest point on the circle remains within the robot's reachable workspace which is 1-meter.

**Display or Graphic visualization of the circle:**

Our code also plots the graphic visualization of the circle to help users visualize the circle in the graph as well as the sizes based on the user input. This would help users understand where they can place the circle and what radius is valid based on the center's position.