Implementation of biologically-inspired dynamical systems for movement generation: automatic real-time goal adaptation and obstacle avoidance

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***Abstract*—**

I. Introduction

Our two papers [1], [2]

II. Approach

A. Distance to objects

To compute the closest distance between two objects we first obtain the closest points between the objects and then the distance between these two points.

1) Sphere - Sphere: To compute the closest distance between two spheres, one can easily calculate the distance between the center of both spheres and subtract the radius of both spheres.

2) Sphere - Capsule: To compute the closest distance between a capsule C and a sphere S, one can compute the distance between the center of $S = p_S$ and the axis of symmetry of $C = l_C$ and then subtract the radius of the sphere and the capsule.

The closest point, on l_C, to p_S is given by (1),

$$\begin{aligned} x &= x_1 + \lambda(x_2 - x_1) \\ y &= y_1 + \lambda(y_2 - y_1) \\ z &= z_1 + \lambda(z_2 - z_1) \end{aligned} \tag{1}$$

where the start point of l_C is $m1(x_1, y_1, z_1)$, the end point is $m2(x_2, y_2, z_2)$, and λ is given by (2).

$$\lambda = \frac{(c - m_1)\cdot(m_2 - m_1)}{l^2} \tag{2}$$

3) Capsule - Capsule: To compute the closest distance between two capsules (capsule A and capsule B), with axis of symmetry $l_A = \overline{m1_A m2_A}$ and $l_B = \overline{m1_B m2_B}$, where A is the longest capsule, one can consider four different cases:

1) $m1_B$ and $m2_B$ can be perpendicularly projected onto l_A
2) $m1_B$ and $m2_B$ cannot be perpendicularly projected onto l_A
3) only $m1_B$ can be perpendicularly projected onto l_A
4) only $m2_B$ can be perpendicularly projected onto l_A

Depending on these cases, the following steps are going to be calculated with different objects.

In case 1, capsule M will be capsule A, and capsule O will be capsule B.

In case 2, if $m1_B$ is closer to l_A than $m2_A$ is to l_B, then capsule M will be capsule A, and capsule O will be capsule B. Else capsule M will be capsule B, and capsule O will be capsule A.

In case 3, if $m2_B$ is closer to l_A than $m1_A$ is to l_B, then capsule M will be capsule A, and capsule O will be capsule B. Else capsule M will be capsule B, and capsule O will be capsule A.

In case 4, if if $m1_B$ is closer to l_A than $m2_B$ is to l_A, then capsule M will be capsule A, and capsule O will be capsule B. Else capsule M will be capsule B, and capsule O will be capsule A.

With capsule M and capsule P, one can follow the next steps. The first step is to place the reference frame of M in its center of mass, with the Z-axis in the direction of l_M. The second step is to project l_O onto the XY-plane given by the reference frame of M (Figure 1), the result of this projection would be the line l_P. The third step is to calculate the closest point on l_P to the origin of the reference frame of P by using (1). The final step is to compute the distance and subtract the radius of the capsule and the sphere. If the true closest points on the original axis of symmetry of the capsules are needed, one can project back the obtained points.

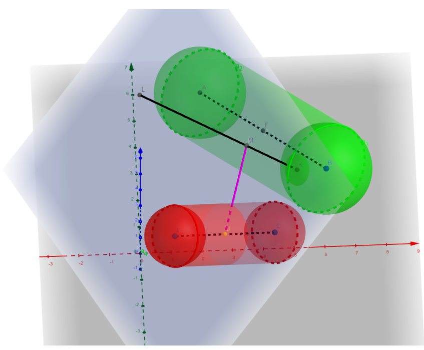

Fig. 1. Capsule - capsule

B. Collision monitoring

C. Potential field

D. Controller

III. Experiments

A. Testing

B. ROS

C. Results

IV. Use case

A. Single arm

B. Dual arm

C. Self collision

V. Conclusion

Appendices

Acknowledgments

References

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[3] S. Adee, Dean Kamens Luke Arm Prosthesis Readies for Clinical Trials - IEEE Spectrum, IEEE Spectrum: Technology, Engineering, and Science News, Feb. 01, 2008. https://spectrum.ieee.org/biomedical/bionics/dean-kamens-luke-arm-prosthesis-readies-for-clinical-trials (accessed Jun. 25, 2020).

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