2-Dimensional Generalized Geometry Contact Algorithms between Rigid and Flexible Curve Geometries

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Abstract
An efficient and fast contact analysis of the multi-flexible-body dynamics (MFBD) is an very important issue in the area of computational dynamics because the realistic dynamic analysis of many mechanical systems includes the contacts between rigid and flexible bodies. In order to satisfy these kinds of fundamental requirements, lots of contact algorithms or contact elements have been studied and developed. But, most of contact researches were usually focused on the 3-dimensional contact analysis. Of course, some advanced contact algorithms shows a very efficient and robust contact analysis results. But, the contact analysis is still a big time-consuming part when we perform the contact analysis because the complex 3D shape of the contact geometries make the problem difficult in general.

The previous work of this study is GGEOM (Generalized Geometry) contact element [2-4]. This contact element is called “Geo” or “GEO” contact and this contact element is available in RecurDyn V8R2 or later versions [5]. Basically, the previous work or GEO contact element was focused on the contact analysis between general surfaces which can be defined with rigid or flexible bodies. But, there can be lots of situations in which we can assume the problem as a 2-dimensional contact analysis problem. In this situation, the 2-dimensional contact analysis will be absolutely more efficient and faster than the 3-dimensional analysis. To resolve this situation, this study proposes a general purpose 2-dimensional GEO Curve (Generalized Geometry for Curve) contact algorithms.

The proposed contact algorithms are using a compliant contact force model based on the Hertzian contact theory. First of all, to define the 2-dimensional contact problems, the contact plane is defined from the 3-dimensional analysis model. Also, in order to evaluate the smooth contact force, the penetration depth and contact normal directions are evaluated by using the Hermite curve equation.

For the robust and efficient contact algorithm development, the contact algorithms are divided into four main parts which are a geometry representation for curves, a pre-search, a detailed search and a contact force generation. In the geometry representation part, we use the straight line segments or curved segments which can be used for curved geometries. In the pre-search, the algorithm performs collision detection and composes the expected contact pairs for the detailed search. In the detailed search, the penetration depth and contact reference frame are calculated. In particular, for the curved geometry, the Hermite curve equation is used in order to represent the curve geometry more accurately. This can generate more accurate and smooth contact force results. Finally in the contact force generation part, we evaluate the contact force and Jacobian matrix for the implicit time integrator.

Figure 1 shows a kinematic notation conventions for the base contact curve geometry. Figure 2 shows the example of the subdivision of bounding box for the contact curve geometry. This subdivision will enhance the performance of the contact pre-search. Figure 3 shows the example of the data management method to enhance the pre-search performance. This grid cell information will be used when the contact pairs are searched in the pre-search stage. Finally, Figure 4 shows the node-to-

segment collision pattern for the detailed search. From this detailed search, the contact normal force and the contact friction force will be evaluated.

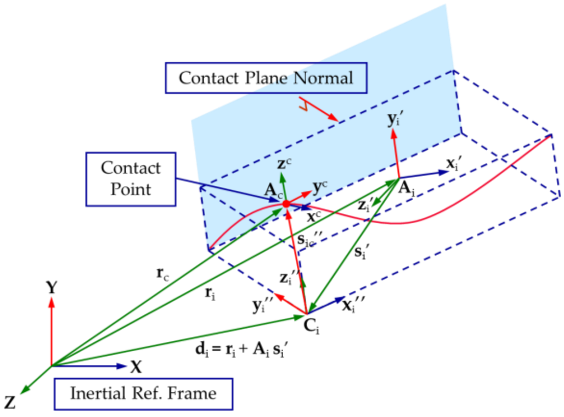

Figure 1 : Kinematic notation conventions of a base contact curve geometry and a contact reference frame.

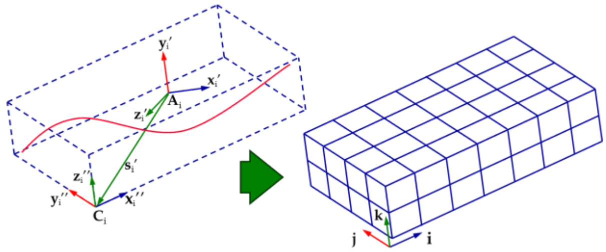

Figure 2 : Subdivision of bounding box of contact curve geometry.

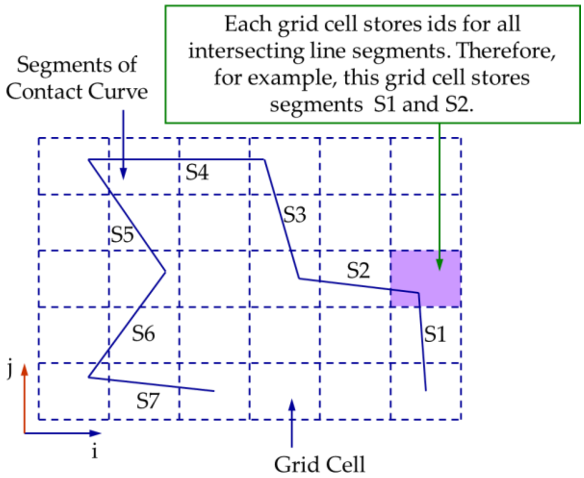

Figure 3 : The information of data storage for each grid cells for the pre-search.

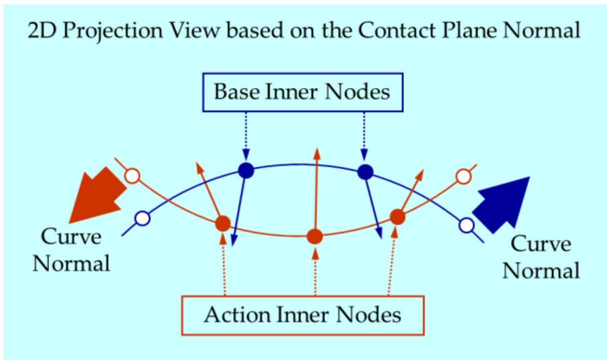

Figure 4 : The Node-To-Segment collision pattern for the detailed search.

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