Overlap Areas of a Square Box on a Square Mesh

by James U Cazamias
NOTICES

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To aid in a data-reduction process, an algorithm was generated to calculate on a square mesh (elements with sides of length 2m) the area of overlap for individual elements with a square box (sides of length 2n) that is not rotated relative to the mesh subject to the constraint n < 2m.

15. SUBJECT TERMS
data reduction, square mesh, overlapping squares, construction geometry, algorithm
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1. Objective

To aid in a data-reduction process, an algorithm was generated to calculate on a square mesh (elements with sides of length 2m) the area of overlap for individual elements with a square box (sides of length 2n) that is not rotated relative to the mesh subject to the constraint n < 2m.

2. Algorithm

Ignoring edge elements, we can assume the following construction (Fig. 1) without loss of generality: 1) a 3 × 3 mesh with the coordinate system’s origin at the center of the middle element and 2) a square box with center (x,y), which also lies in the middle element. The constraint ensures that the box lies entirely within the 3 × 3 mesh. We label the elements (i,j) with i,j = 1,2,3. We define the overlap area of an individual mesh element (i,j) with the box as $A_{ij}$. Since the box is not rotated relative to the mesh, notice that the overlap areas are rectangles with sides $\Delta x_i$ and $\Delta y_j$ with

$$A_{ij} = \Delta x_i \Delta y_j.$$  (1)
The terms $\Delta x_2$ and $\Delta y_2$ will always be nonzero, but we need to check if $\Delta x_1$, $\Delta y_1$, $\Delta x_3$, and $\Delta y_3$ are nonzero as well. The terms $\Delta x_1$ and $\Delta y_3$ are determined using Table 1 and Eqs. 2 and 3.

Table 1  Construction definitions

<table>
<thead>
<tr>
<th>If</th>
<th>Then</th>
<th>Else</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x - n &lt; -m$</td>
<td>$\Delta x_1 = n - x - m$; $x^- = -m$</td>
<td>$\Delta x_1 = 0$; $x^- = x - n$</td>
</tr>
<tr>
<td>$x + n &gt; m$</td>
<td>$\Delta x_3 = n + x - m$; $x^+ = m$</td>
<td>$\Delta x_3 = 0$; $x^+ = x + n$</td>
</tr>
<tr>
<td>$y - n &lt; -m$</td>
<td>$\Delta y_3 = n - y - m$; $y^- = -m$</td>
<td>$\Delta y_3 = 0$; $y^- = y - n$</td>
</tr>
<tr>
<td>$y + n &gt; m$</td>
<td>$\Delta y_1 = n + y - m$; $y^+ = m$</td>
<td>$\Delta y_1 = 0$; $y^+ = y + n$</td>
</tr>
</tbody>
</table>

$\Delta x_2 = x^+ - x^-$.  \hspace{1cm} (2)

$\Delta y_2 = y^+ - y^-$.  \hspace{1cm} (3)