Four-bar Linkage Synthesis for A Combination of Motion and Path-point Generation

Yuxuan Tong
Advisor: Andrew P. Murray, David Myszka

Objective: To develop techniques that address the design of planar four-bar linkages for tasks common to pick-and-place devices, common in assembly and manufacturing operations.

Introduction
- Pick-and-place machines are mechanical devices designed to repetitively perform a specific sequence of part movements

Numerical Methodology
- Numerical methods formulate the kinematic chain constraint equations and solve for the appropriate link lengths and pivot locations.

GCP Methodology
- Geometric Constraint Programming (GCP) is a technique that has the advantages of both the graphical and analytical techniques for the kinematic synthesis

Examples
- Combination have finite solutions: 4 positions and 2 points
- Combination have 1-parameter solutions: 3 positions and 3 points

Conclusion
- Techniques developed to design planar four-bar linkages for tasks common to pick-and-place devices.

<table>
<thead>
<tr>
<th>No. of Task Positions</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Precision Points</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>No. of Eqs. and Variables</td>
<td>8</td>
<td>12</td>
<td>16</td>
<td>20</td>
<td>24</td>
<td>24</td>
</tr>
</tbody>
</table>

Vectors
\[ Z_{1i} = T_i z_1 + d_i \]
\[ Z_{2i} = T_i z_2 + d_i \]
\[ L_{1i} = Z_{1i} - G_1 \]
\[ L_{2i} = Z_{2i} - G_2 \]

System Equations
\[ L_{1i} L_{1i} - L_{11} L_{11} = 0 \]
\[ L_{2i} L_{2i} - L_{21} L_{21} = 0 \]
\[ i = 2, 3, 4, 5, 6. \]