Synthesizing Coupler-Drivers as a Novel Method for Actuating Mechanical Systems

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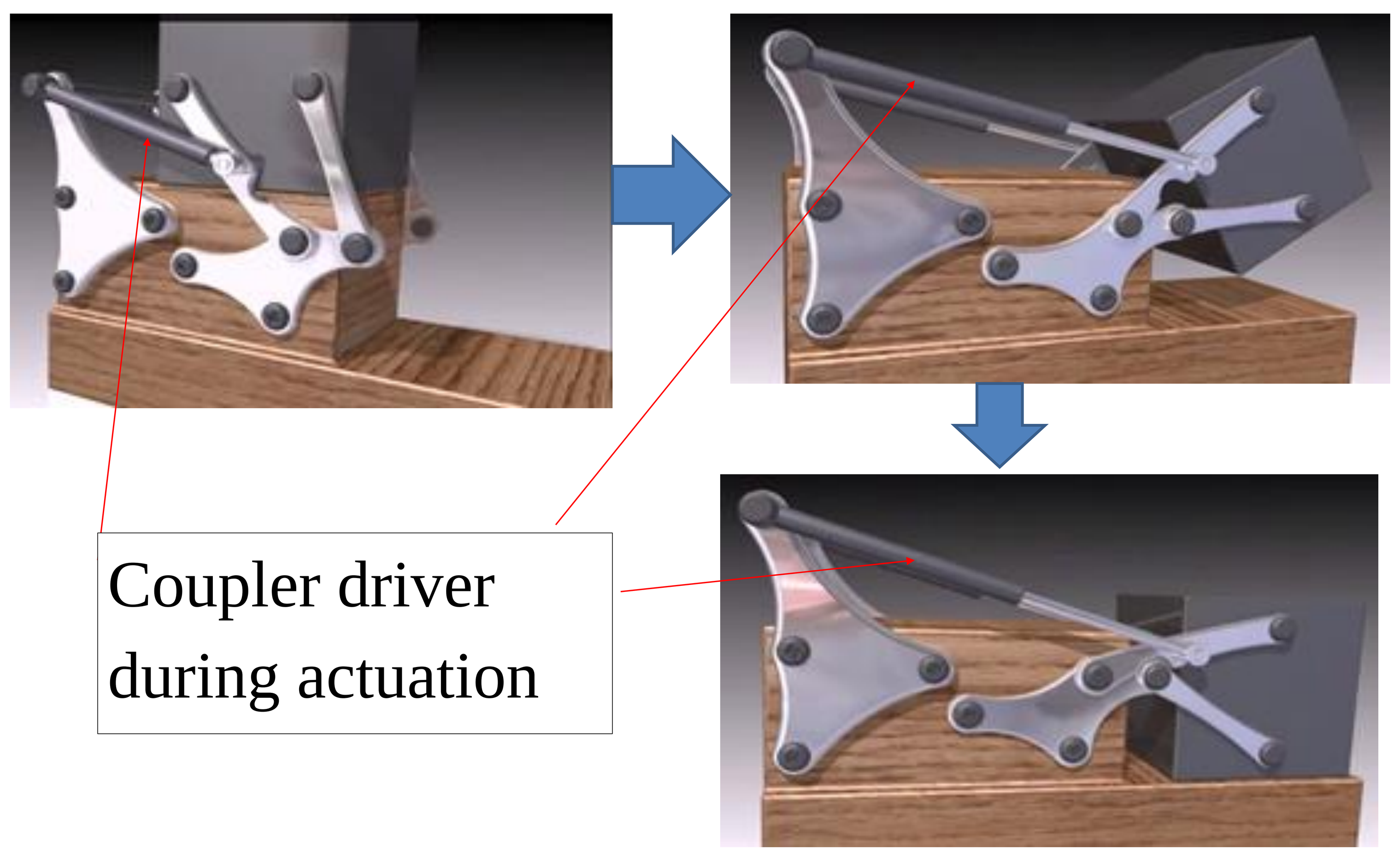
Introduction/Motivation

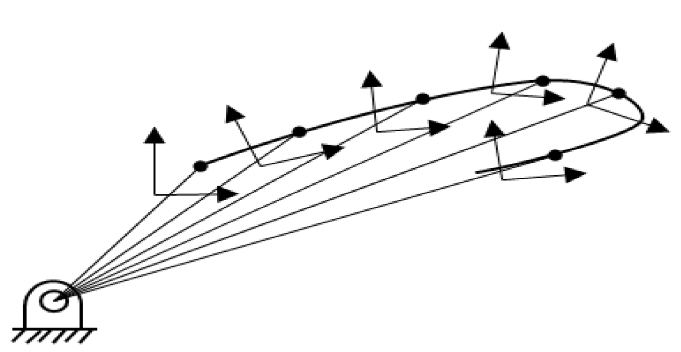
The goal of this research is to change the mechanical design of an automated manufacturing or assembly process by introducing coupler drivers.

This work proposes to develop the kinematic synthesis theory needed to design a coupler driver for any single degree of freedom mechanical system.

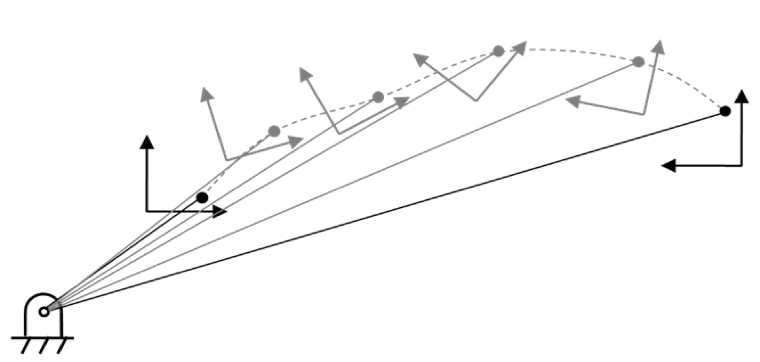


During the kinematic synthesis of a single degree of freedom mechanism for a given task, a challenge is finding a solution mechanism that is not hindered by branch singularities relative to any of its driving joints

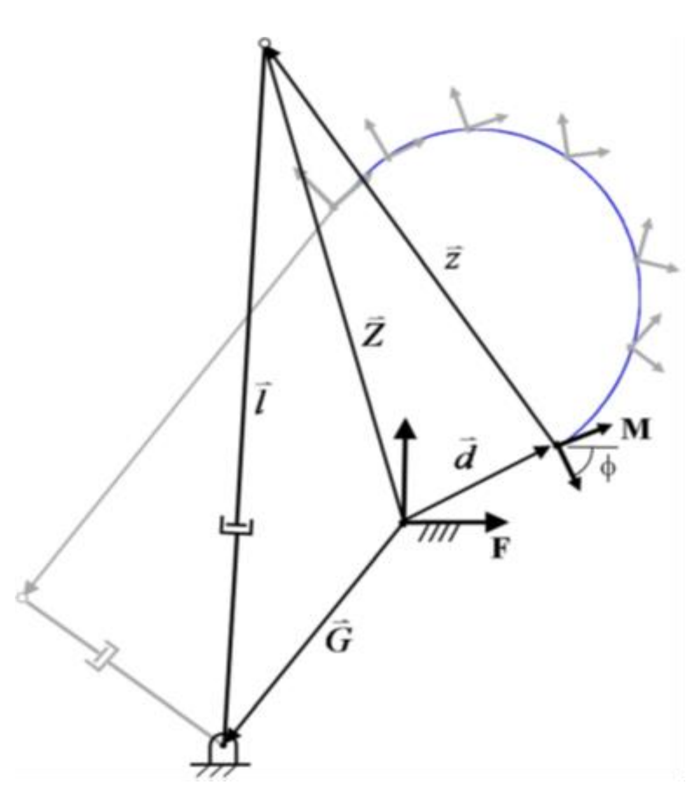
$$\bar{l}^T\dot{\bar{l}} = (A\bar{z}+\bar{d}-\bar{G})^T(\dot{A}\bar{z}+\dot{\bar{d}}) = [\bar{z}^T \quad 1]B\begin{Bmatrix}\bar{G}\\ 1\end{Bmatrix} = \zeta^T B\bar{\Gamma} = 0$$



Non monotonic pattern for the fixed pivots



Monotonic pattern for the fixed pivots



Methodology

-A Mathematical analysis will be implemented to break down the motion of the coupler-driver by using the vector analysis of motion

-A MATLAB code for solving the mathematical model will be developed. The MATLAB code will validate assumptions and verify proposed solutions.

-A CAD model of several proposed mechanisms with coupler drivers will be constructed in SolidWorks to simulate/verify the results from MATLAB.

Results

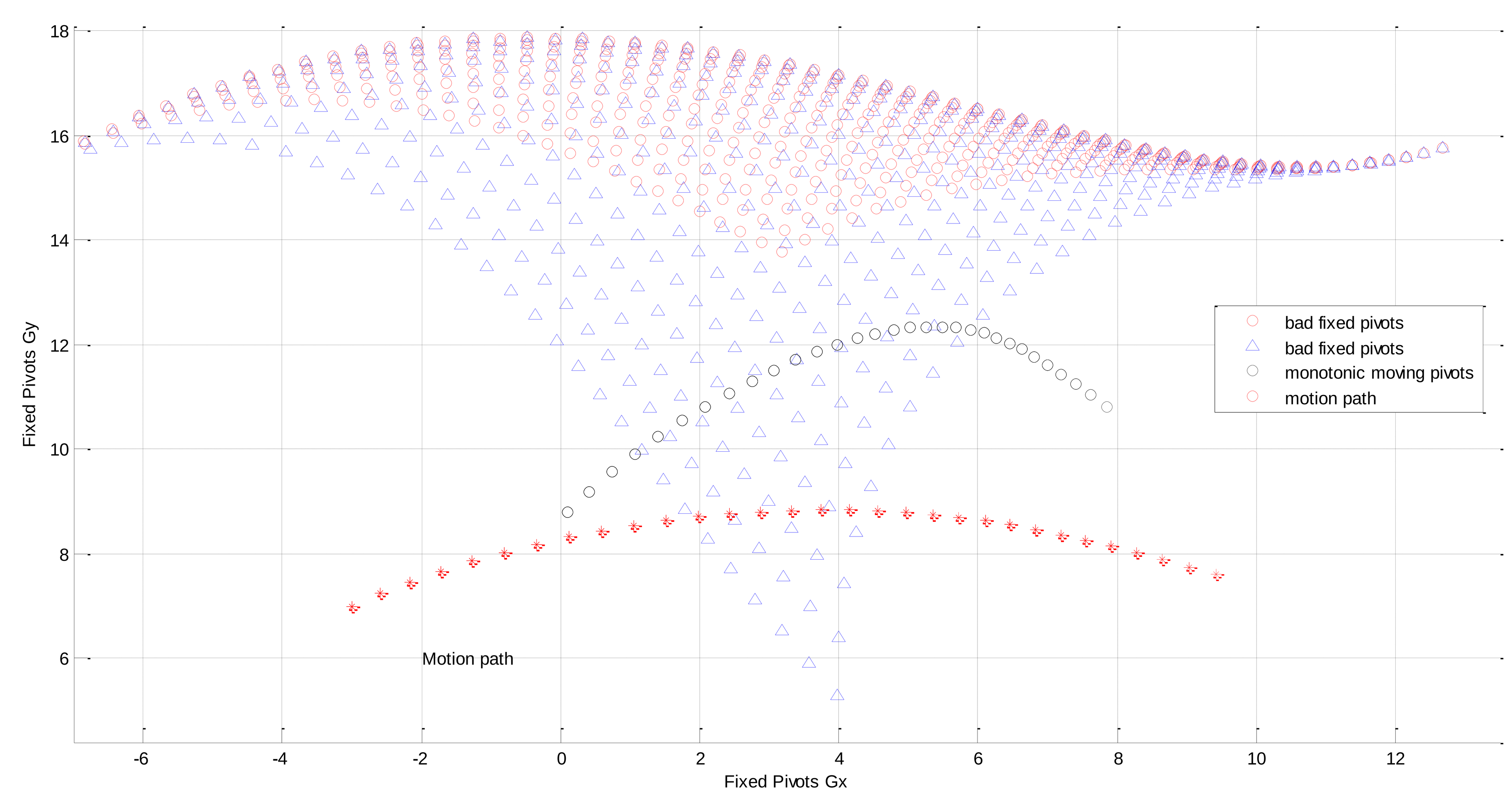
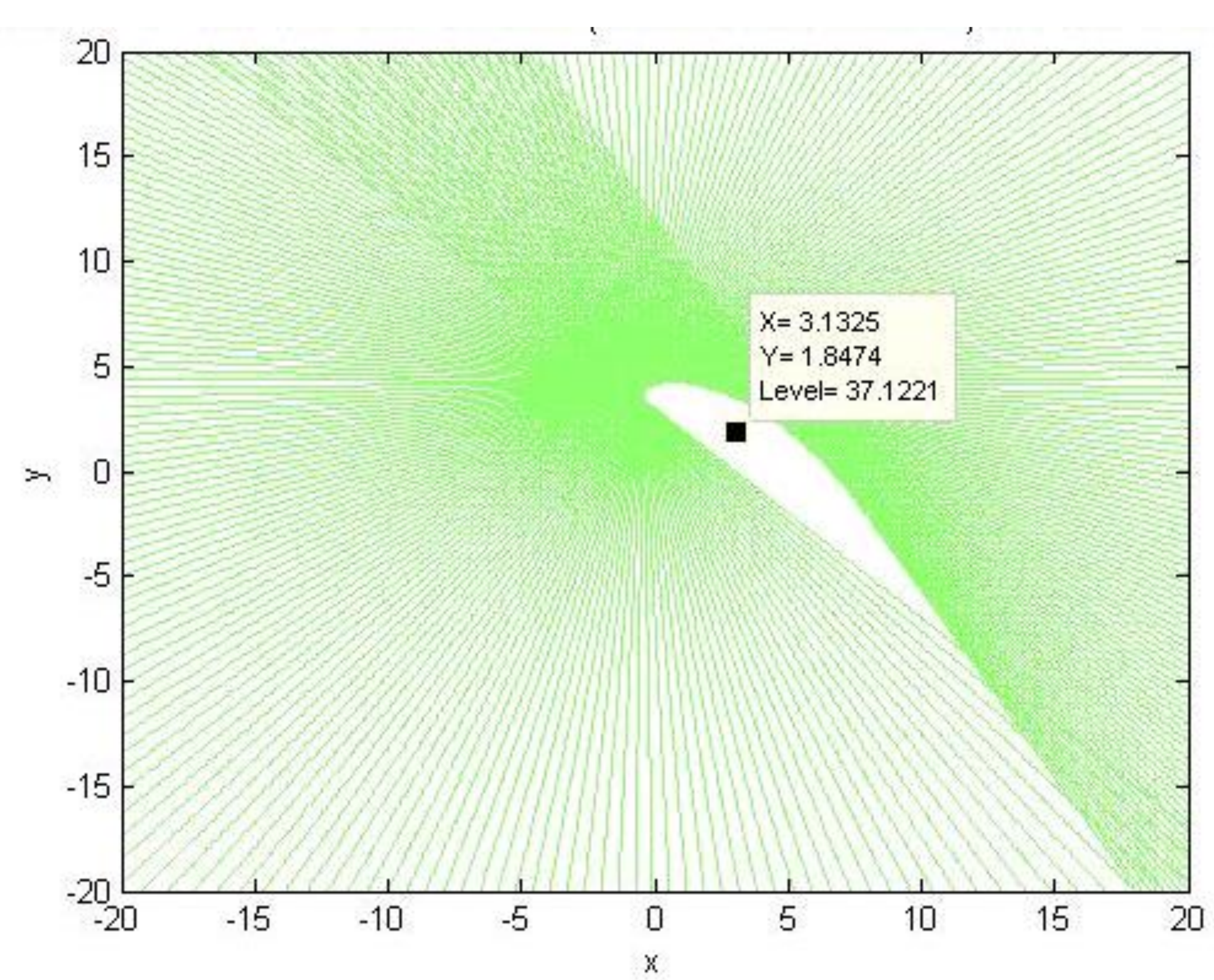


Figure shows the area of singular fixed pivots



Non-monotonic chain at Green region of moving joints. The area indicated in black are the potential moving pivots

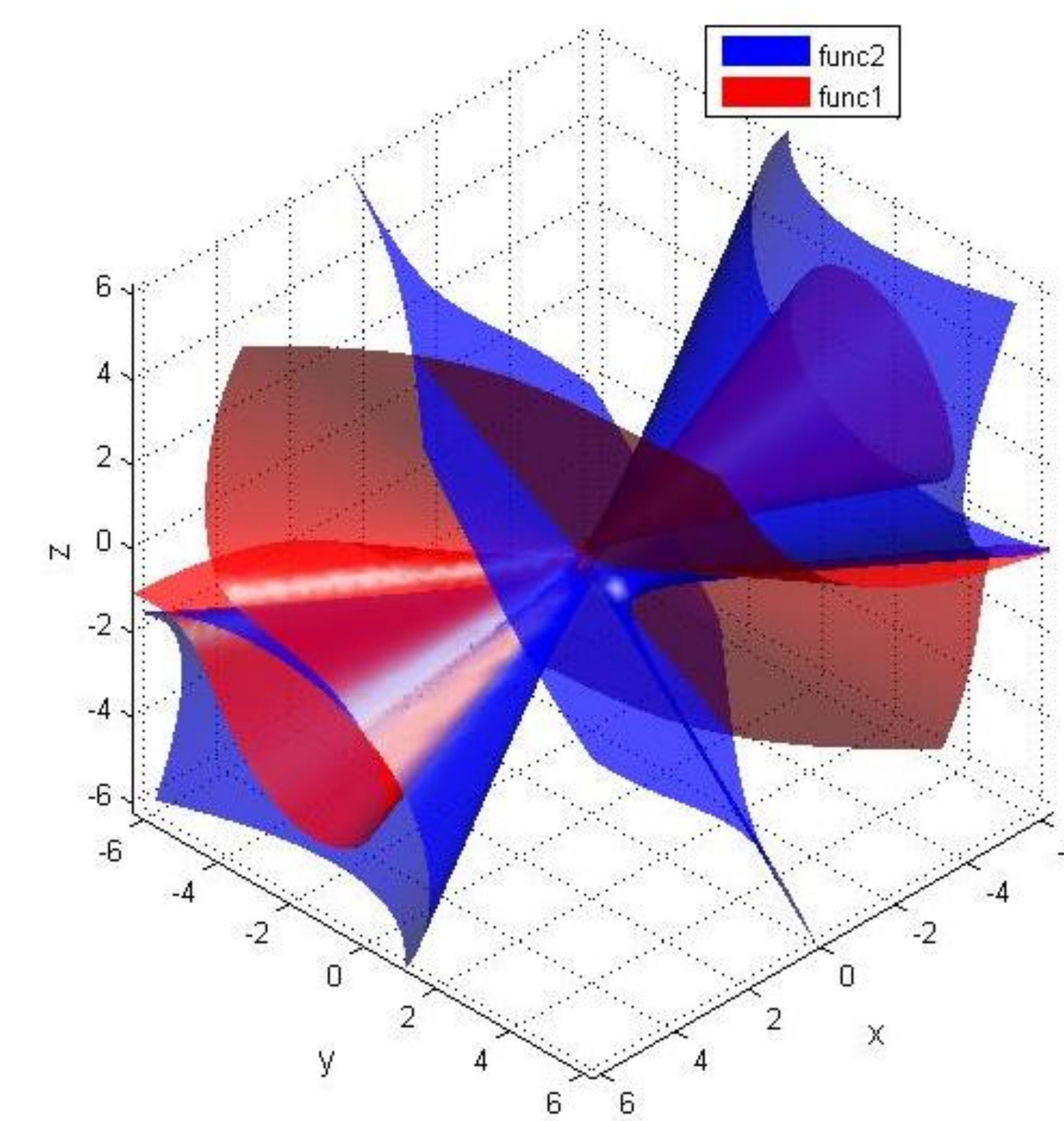
Conclusion

A new method of synthesizing coupler-drivers by calculating the actuator singularity points.

- Applies to any motion generated by a single DOF mechanism
- Generate circuit-defect free solutions, synthesize coupler-driver
- This method shows how to predict the correct pivots locations fixed and moved one that will produce monotonic motion

Future work

- Generalize the coupler-driver synthesis methodology to spatial cases
- The problem requires utilizing the intersection defined by the surfaces depicted below.



The curve defined by the intersection of the 3rd order surface (red) and 4th order surface (blue) includes potential solutions.