NYU POLYTECHNIC SCHOOL OF ENGINEERING

3D Computer Vision: Techniques & Applications

Project 1: ICP Algorithm

Project Deadline: 11:59 PM, Sept. 16, 2015

No late submission will be accepted

In this project, you are asked to transform the given source data to best match the target model by implementing Iterative Closest Point (ICP) Algorithm in **Matlab**. Pseudo code of ICP algorithm is given as following:

Input: source data S, target model M
Output: transformation TT, TR and final transformed (source) data S

Repeat

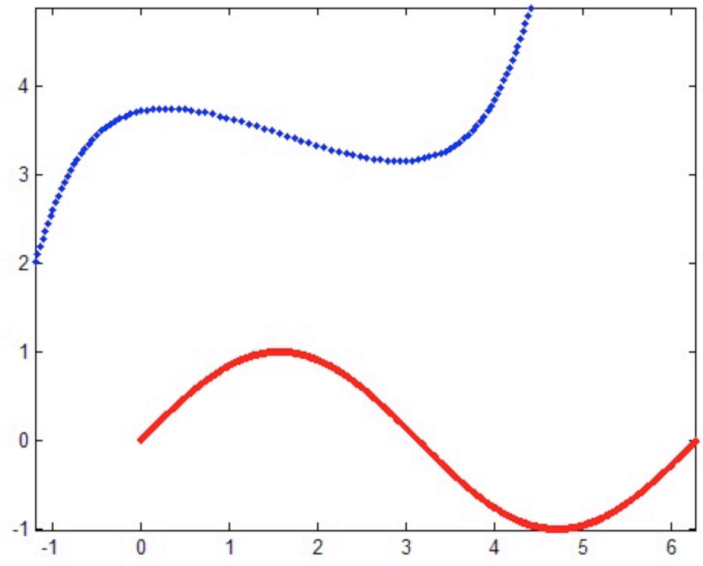
1. For each point in S
   Find its closest point in M → P
2. Compute Centroids of S and M → C_s and C_m
3. Remove corresponding centroid value from each point in S and P → S' and P'
4. Calculate the correlation matrix $H = S' * P'^T$
5. Estimate rotation matrix R using SVD:
   $[U, D, V] = svd(H)$;
   $R = V * U^T$
6. Estimate the translation vector t: $V = C_m - R*C_s$
7. Build the transformation:
   $TR = R * TR$
   $TT = R * TT + V$
8. Transform the points in S using the obtained transformation:
   $S = R * S$
   For each point S_i in S
   $S_i = S_i + V(i)$
9. Calculate *Err* = $1/N \sum || M - S ||^2$

Until convergence

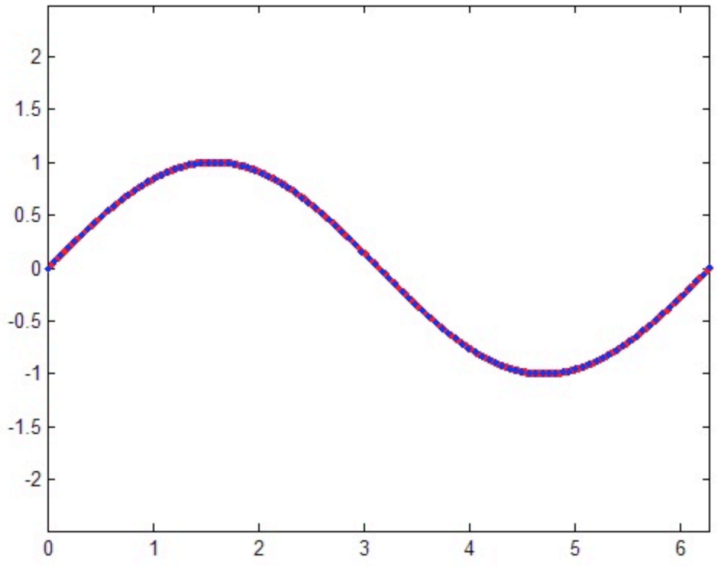
Note: You may use Matlab function *nearestNeighbor* for step 1 and *svd* for step 5. You may discuss the general concepts in this project with other students, but you must finish your program on your own. NO SHARING OF CODE OR REPORT IS ALLOWED. Violation of this policy can result in grade penalty.

Examples for expected experimental result

1. 2D Line without noise (2D_Line.mat) :

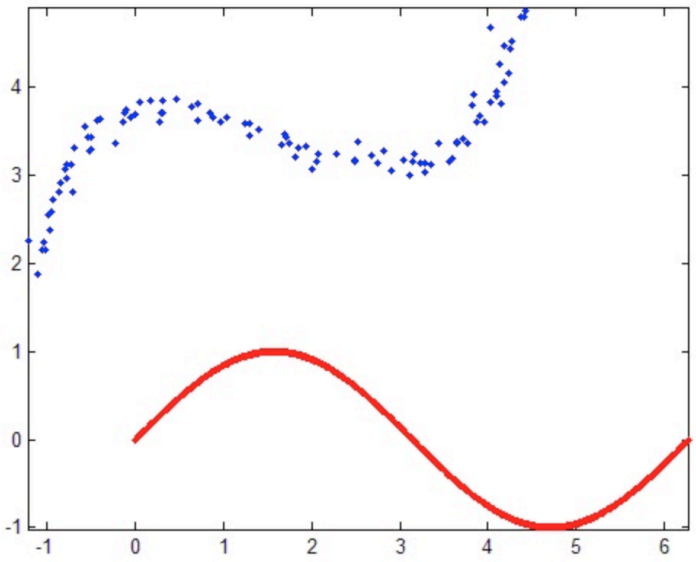


(Blue: Source Data; Red: Target Model)
Data before applying ICP Algorithm

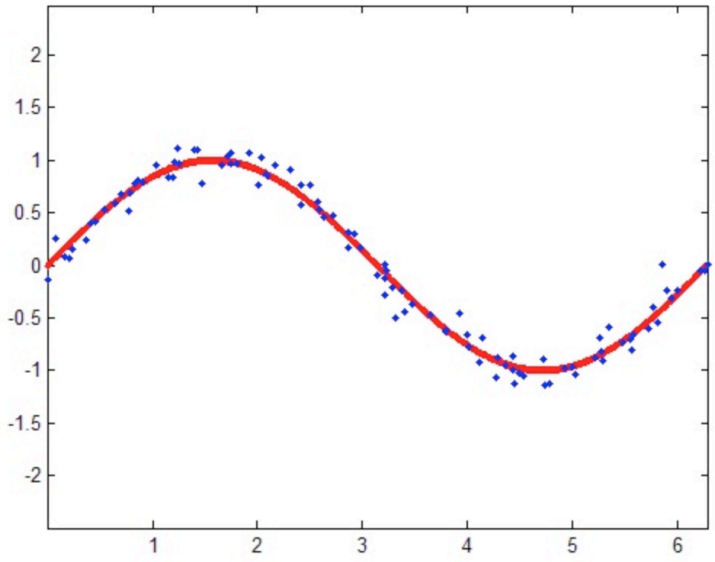


Expected output data (in Blue) after applying ICP Algorithm

2. 2D Line with noise (2D_Line_Noise.mat):

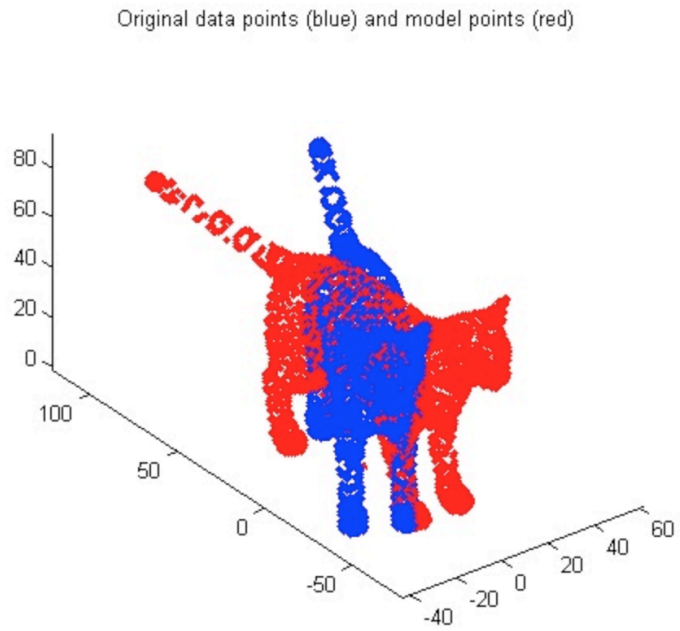


(Blue: Source Data; Red: Target Model)
Data before applying ICP Algorithm

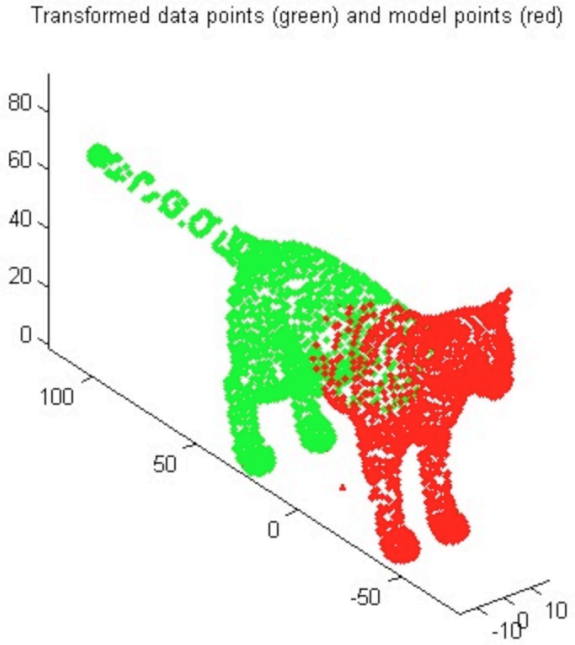


Expected output data (in Blue) after applying ICP Algorithm

3. 3D Cat without noise (3D_Cat.mat):

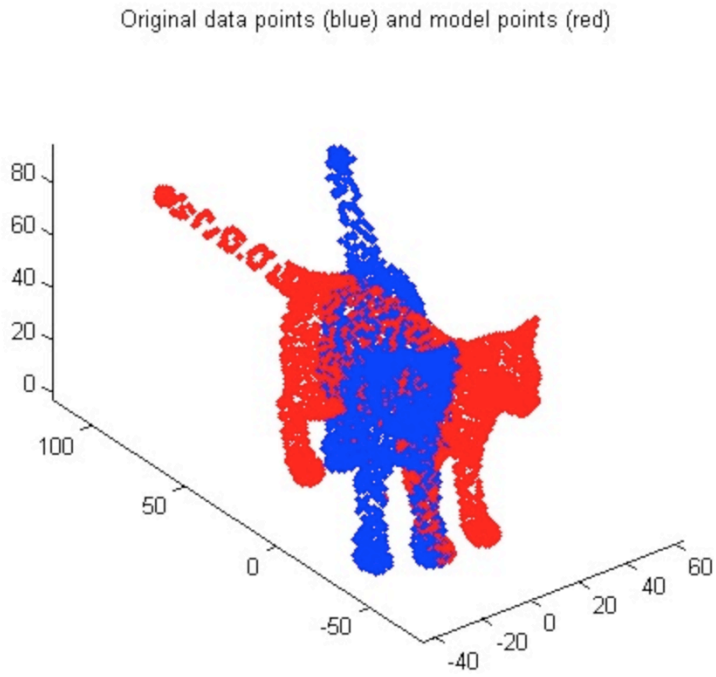


(Blue: Source Data Red: Target Model)
Data before applying ICP Algorithm

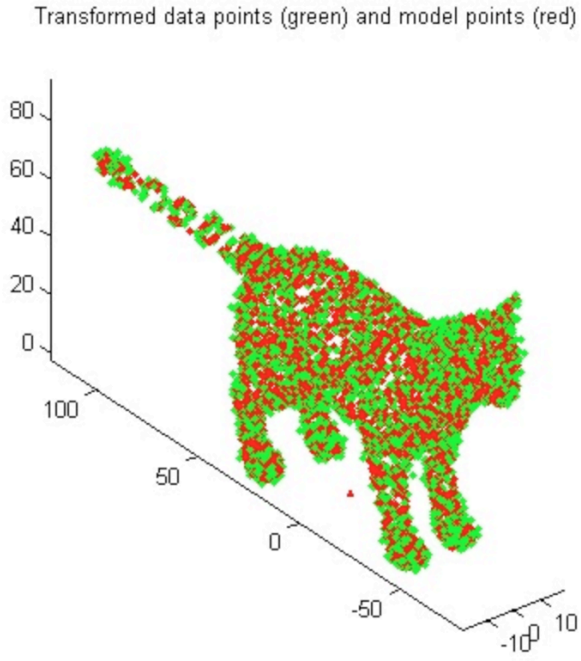


Expected output data (in Green) after applying ICP Algorithm

3. 3D Cat without noise (3D_Cat_Noise.mat):



(Blue: Source Data Red: Target Model)
Data before applying ICP Algorithm



Expected output data (in Green) after applying ICP Algorithm

* Source code for plotting 3D data (you need to modify it so that it works for your program).

```
plot3(model(1,:),model(2,:),model(3,:),'r.',data(1,:),data(2,:),data(3,:),'b.'), hold on, axis equal

plot3([1 1 0],[0 1 1],[0 0 0],'r-',[1 1],[1 1],[0 1],'r-','LineWidth',2)

title('Original data points (blue) and model points (red)')
```

Please submit a working project (source code for ICP algorithm only and experimental testing script) and a report (PDF format) for the detailed description of the project (how the project was coded and how to call your ICP function). Before submitting your project, please make sure test your program on all the given datasets (including 2D and 3D).