

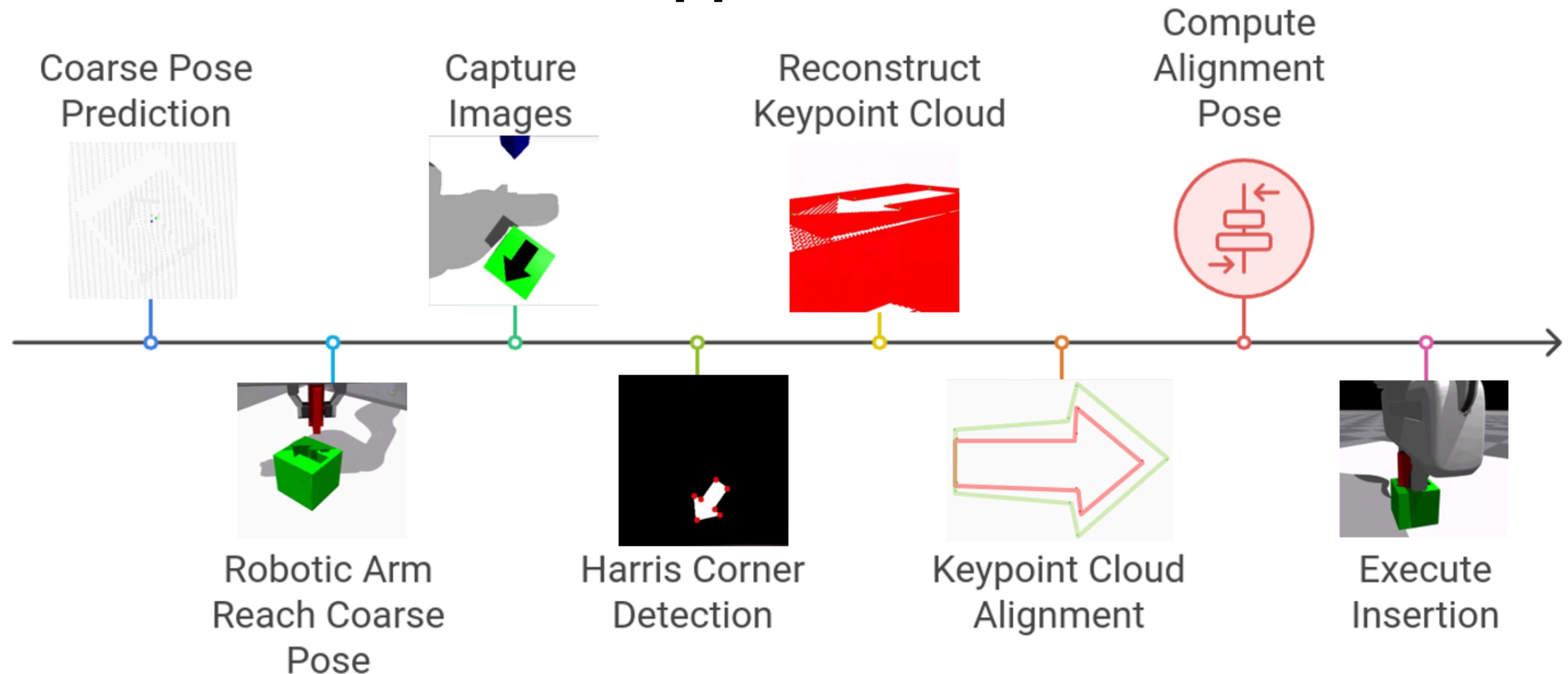
Coarse pose Insertion with Keypoint Detection

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Introduction

In this work, we want to achieve the peg-insertion job with more complex peg and peghole by only using camera observation. we kept and retained the OAKN step of the CFVS process and utilized the traditional Corner Prediction algorithm to identify the keypoints of the peghole and the peg shape. This was done to determine the most suitable insertion pose. For this study, we used an arrow shape as the primary experimental configuration.

Approach

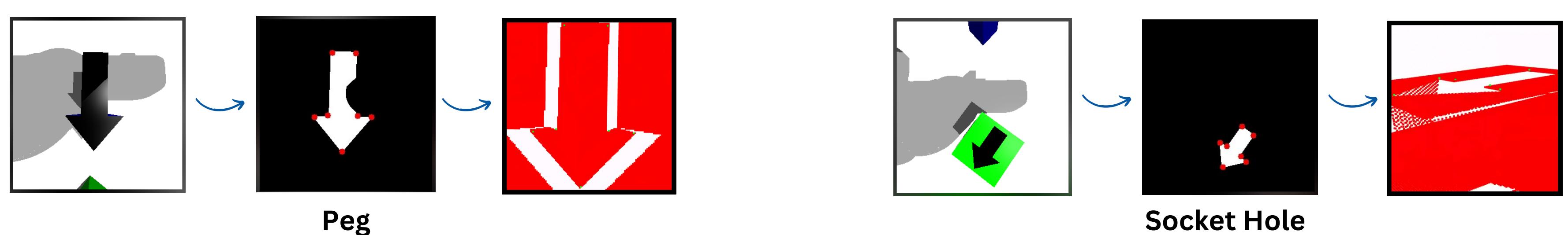


- The structure of coarse pose prediction was the same as OAKN in CFVS [1].
- After getting coarse pose. Harris Corner Detection was utilized on the 2 images to find keypoints of the shapes of peg and hole. The Harris corner detection is to calculate the following equation:

$$R = \det(M) - k \cdot (\text{trace}(M))^2$$

$$M = \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix}$$

The transformation process of keypoints is as follows (original->keypoints detection->point cloud):



- Keypoints are reconstructed as 2 point clouds. The points alignment was then accomplished by minimizing the Euclidean Distance between 2 point clouds (following equation).

$$\min_{R,t} \sum_i \|R \cdot p_i + t - q_i\|^2$$

Evaluation & Discussion

The table on the right is the success rate (tested in 100 environments) comparison of CFVS and our work. Basic shape like square can be easily inserted in both method; our work then performed better in extend shape like arrow.

| | CFVS | our work |
|-------|------|----------|
| Arrow | 5 | 80 |

In this work, we utilized the Harris corner detection and the keypoint alignment to achieve the peg-insertion task. Despite the success of insertion, there were some concerning limitations:

- RGB sensitive
- The framework still strongly depends on the accuracy of coarse pose prediction of OAKN.