Robot Autonomy
Lego Kitting Robot

Team 3

Meet The Team

Alex
Pletta

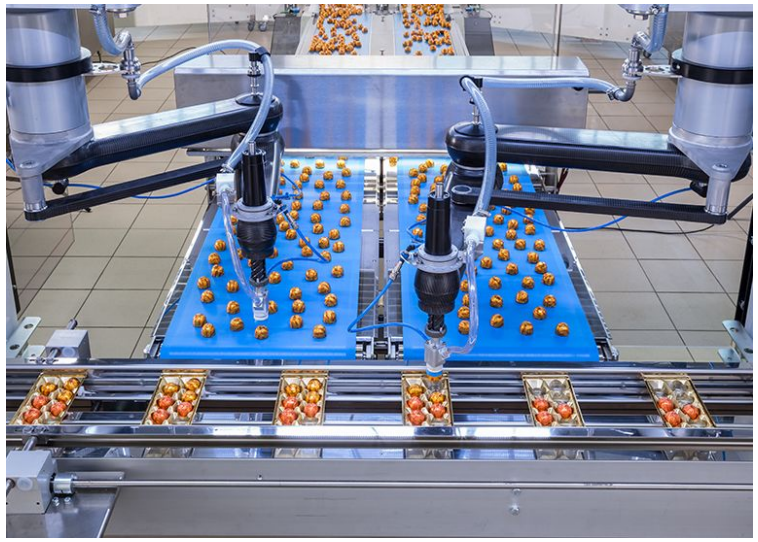
Jaekyung
Song

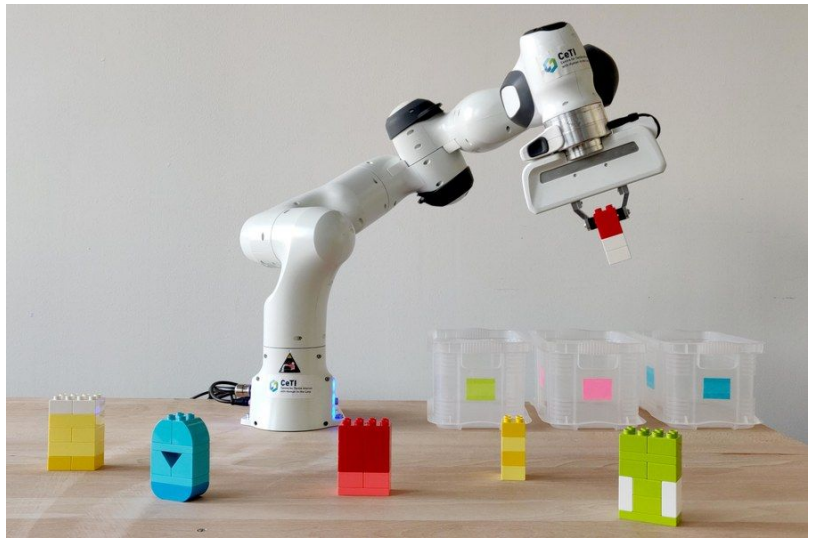
Ben
Younes

Bruce
Kim

Motivation

- User can **request** number of components → **build kit** in minutes
- **Camera** only for **precise manipulation** to construct kits
- **Robust**, **reliable, predictable** (RRP) to enable **cobot**

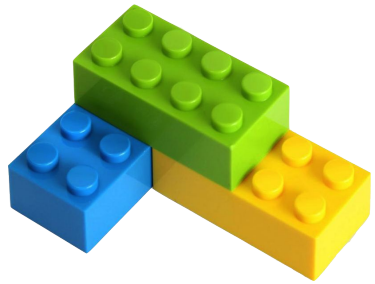


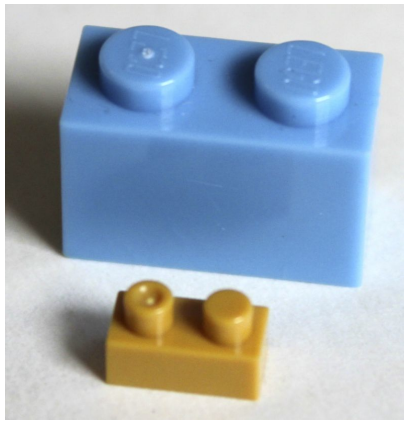


Key Challenges

Variable lighting and shadows

Unexpected and/or undesired objects





Scaled, irregular, and/or cluttered objects

Overview of the Approach

Step 1 | Step 2 | Step 3 | Step 4 | Step 5

System Start:
Request from user

- # Blue
- # Red

Perception:
Detect blocks

- Color
- Size
- Location
- Orientation

Transform & Target:
Image → World
Select Target

- Red, then blue
- Sorted by location consistency

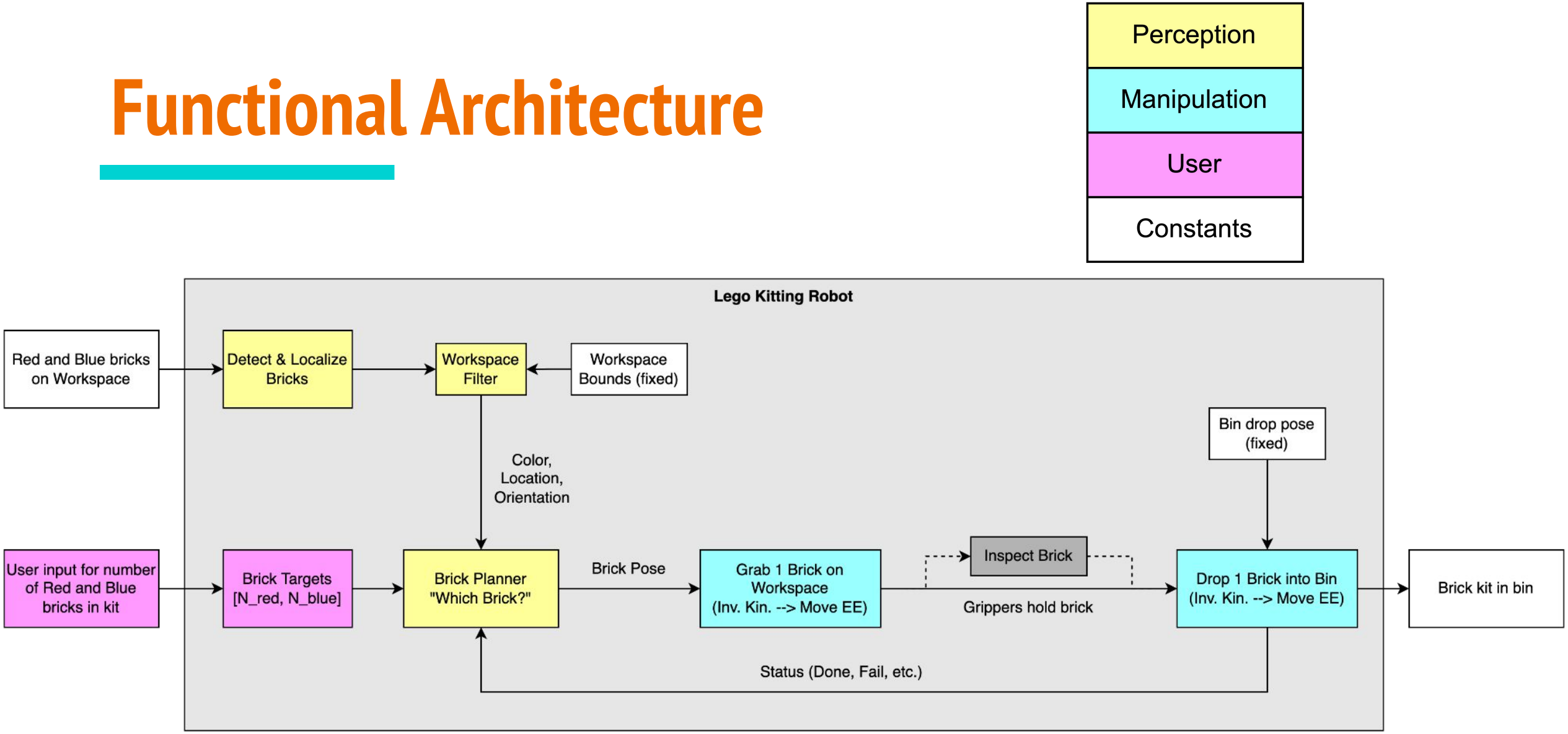
Manipulation:
Take target to kit

- Target pose
- Grasp target
- Drop in kit

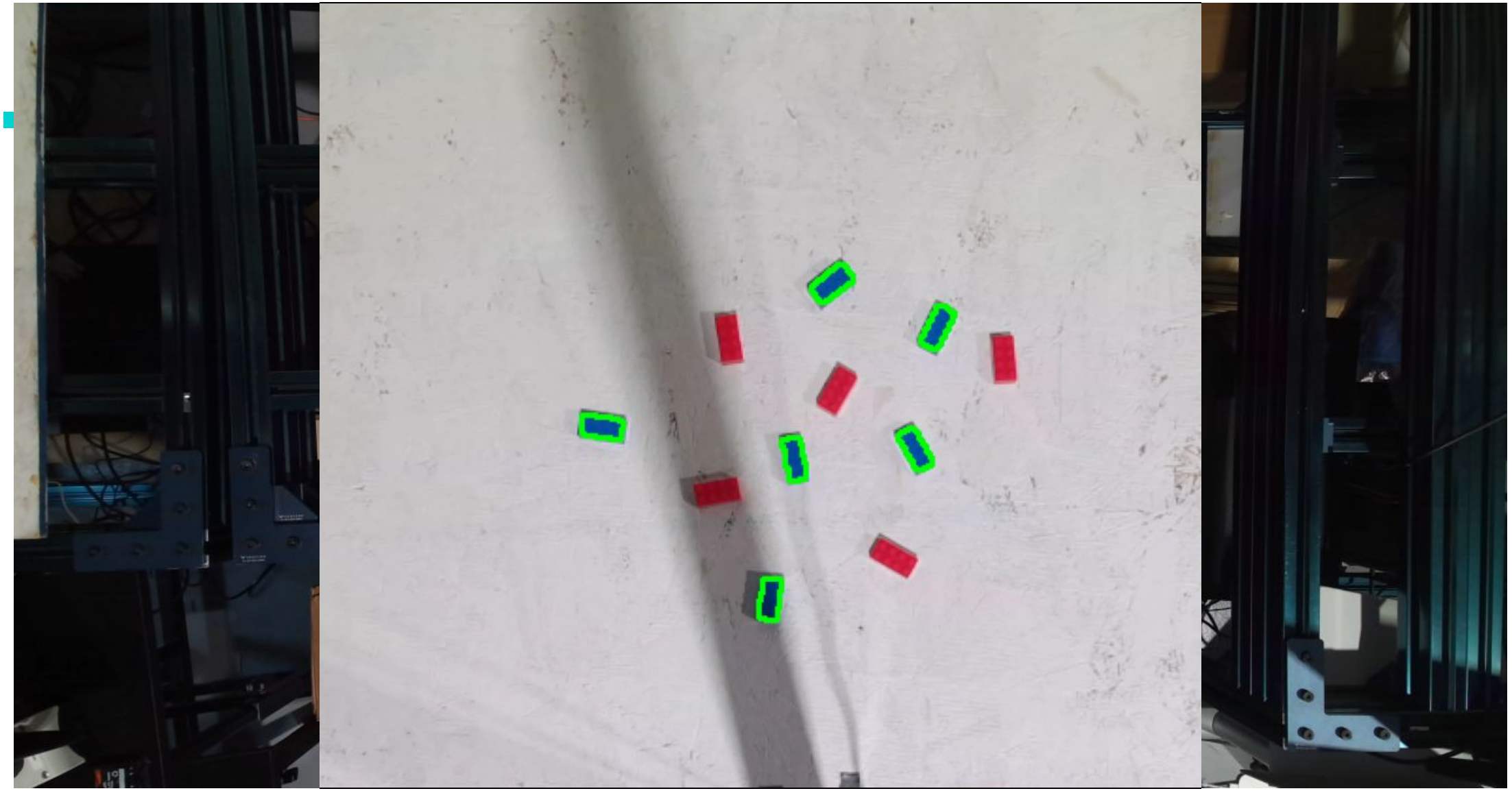
Repeat:
until kit filled!

- All red
- All blue
- Wait if needed

Functional Architecture



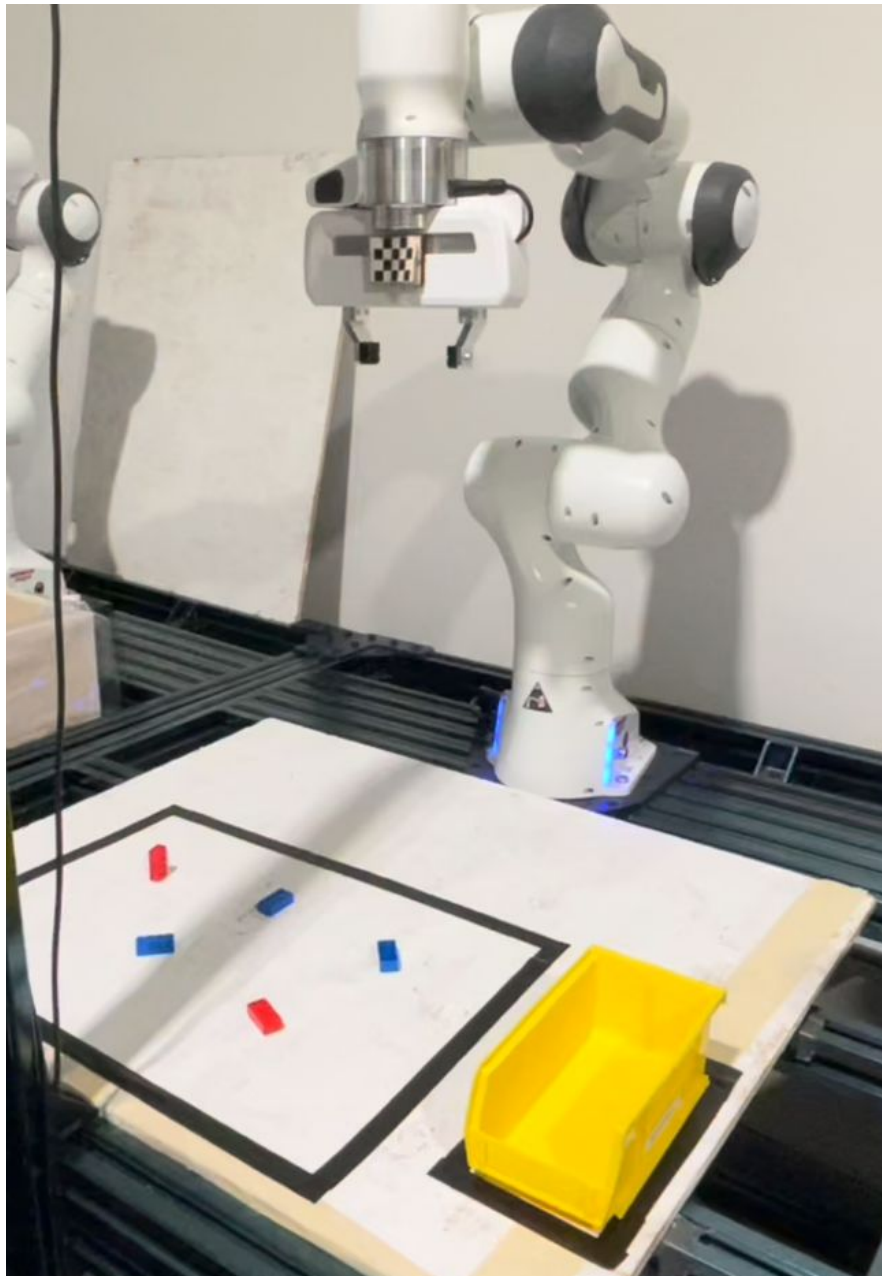
Perception Methods (eg. blue)



Raw > Crop > Normalized > Mask > Contours > Pose estimate

Manipulation Methods

1. Begin from home
2. Select target
    a. Wait until detection: all red, then all blue



Manipulation Methods

1. Begin from home
2. Select target
    a. Wait until detection: all red, then all blue
3. Intermediate target pose

Manipulation Methods

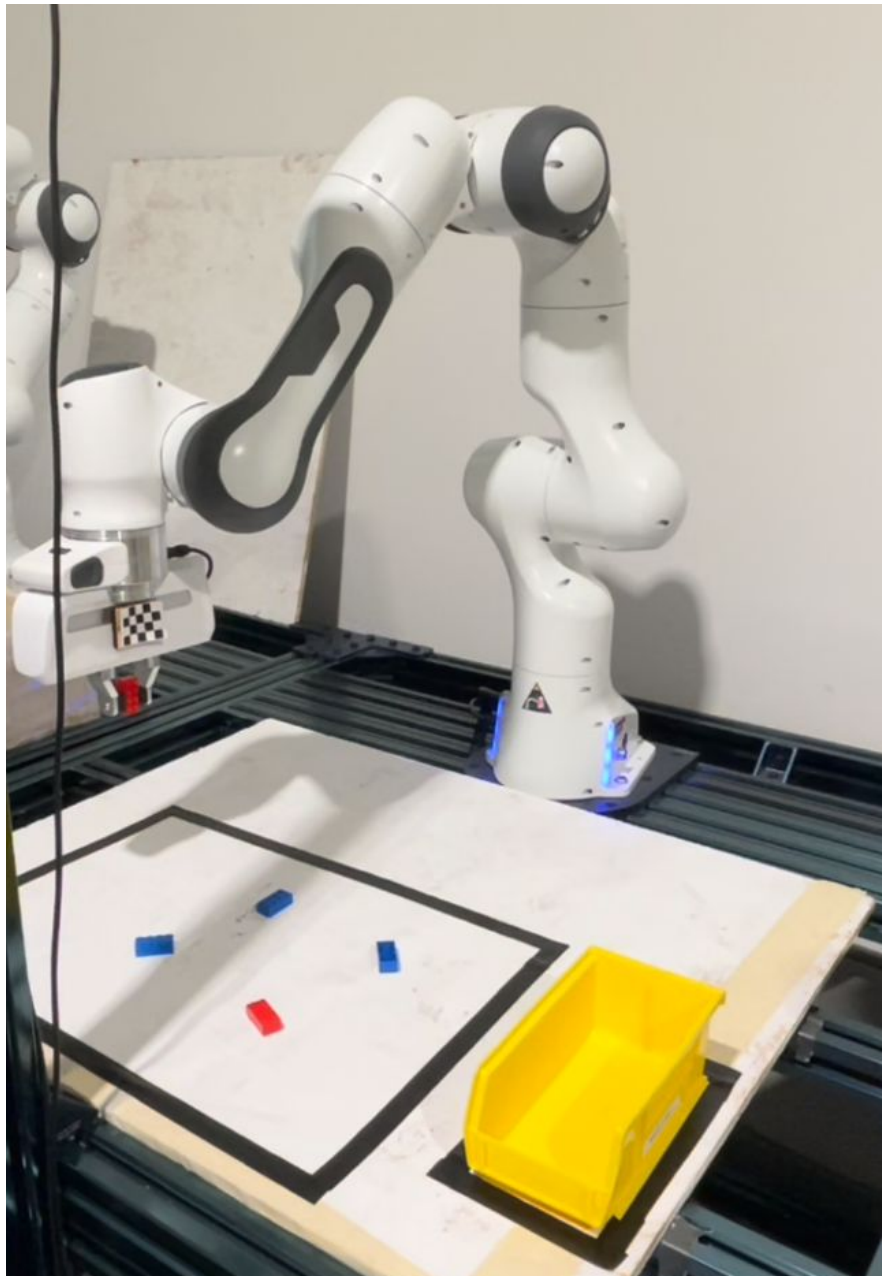
1. Begin from home
2. Select target
    a. Wait until detection: all red, then all blue
3. Intermediate target pose
4. Brick pose

Manipulation Methods

1. Begin from home
2. Select target
    a. Wait until detection: all red, then all blue
3. Intermediate target pose
4. Brick pose
5. Close gripper

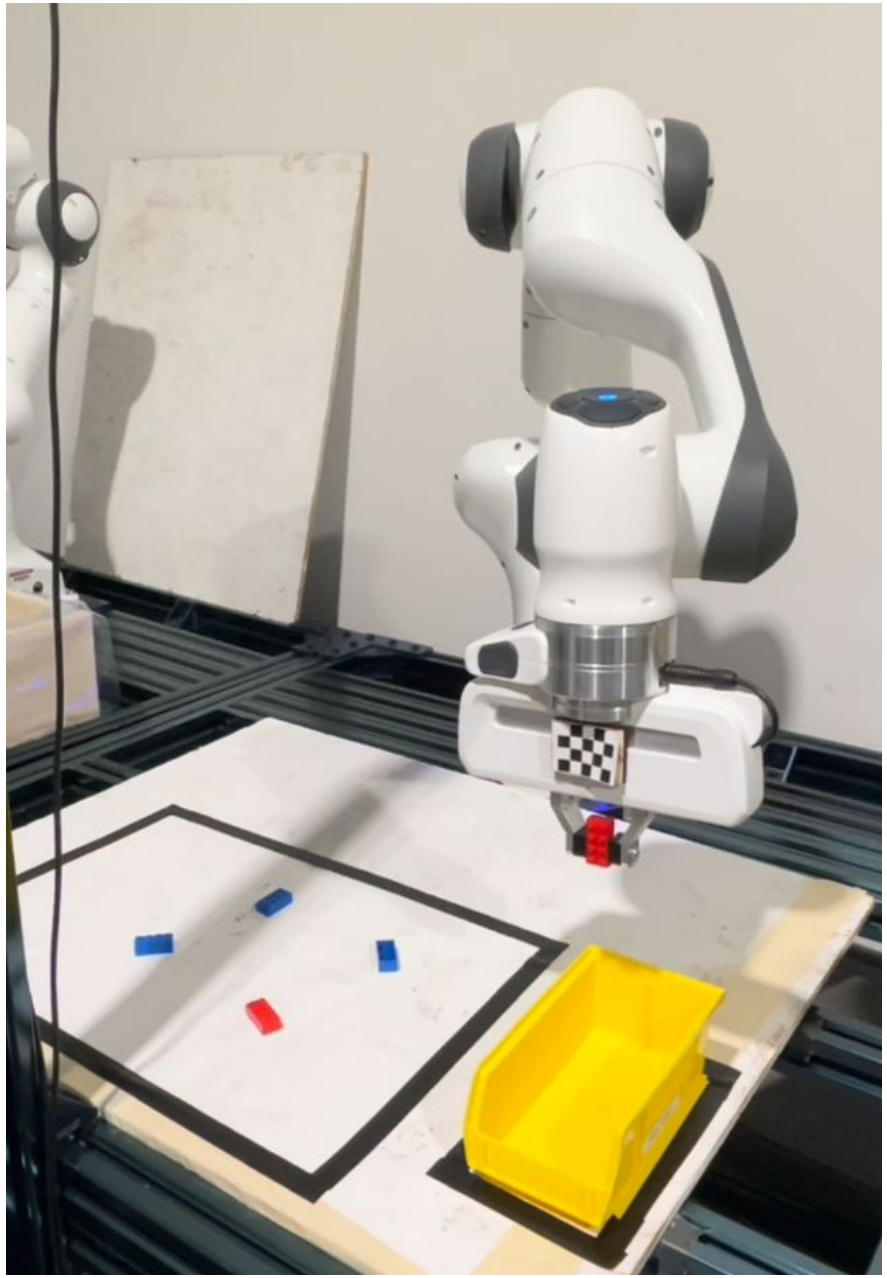
Manipulation Methods

1. Begin from home
2. Select target
    a. Wait until detection: all red, then all blue
3. Intermediate target pose
4. Brick pose
5. Close gripper
6. Intermediate target pose



Manipulation Methods

1. Begin from home
2. Select target
   a. Wait until detection: all red, then all blue
3. Intermediate target pose
4. Brick pose
5. Close gripper
6. Intermediate target pose
7. Move to kit



Manipulation Methods

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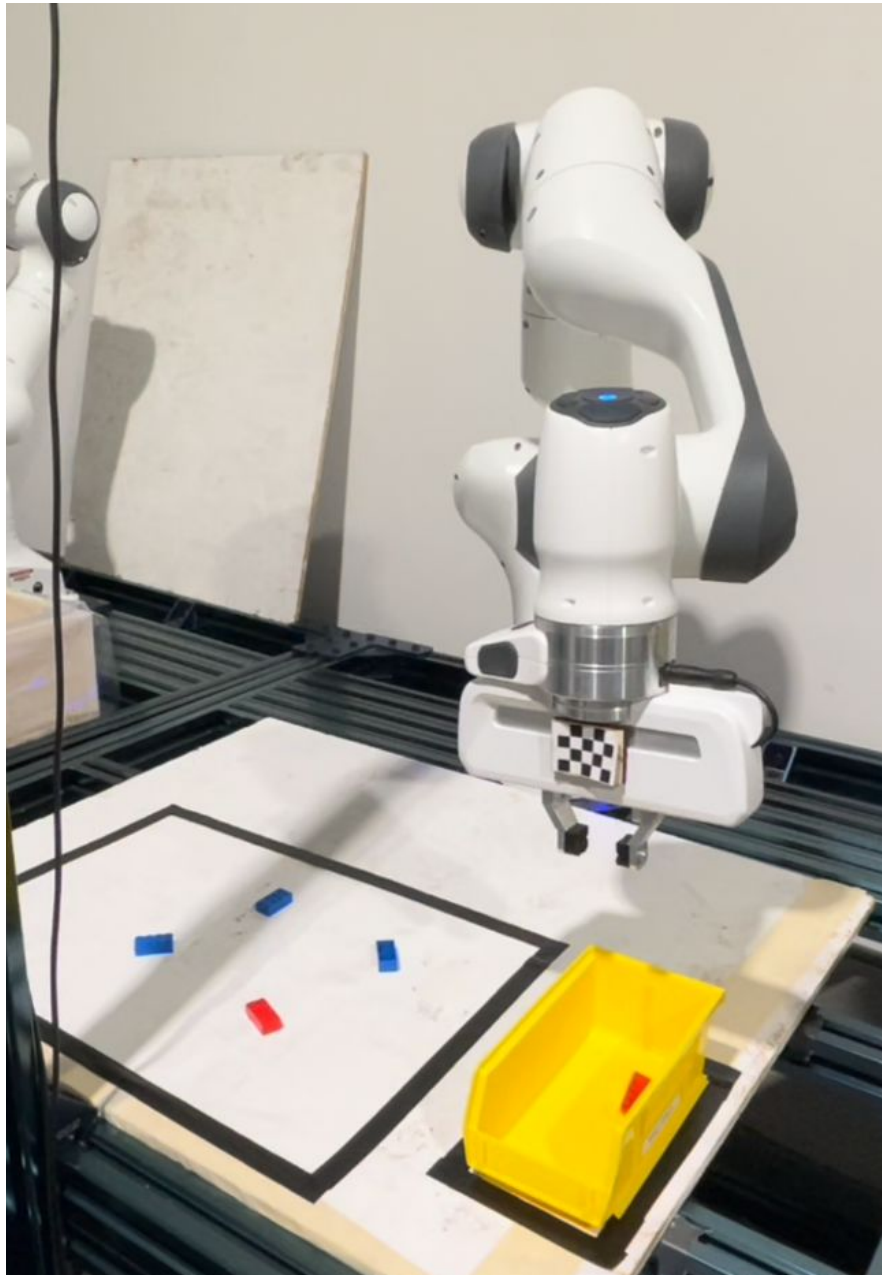
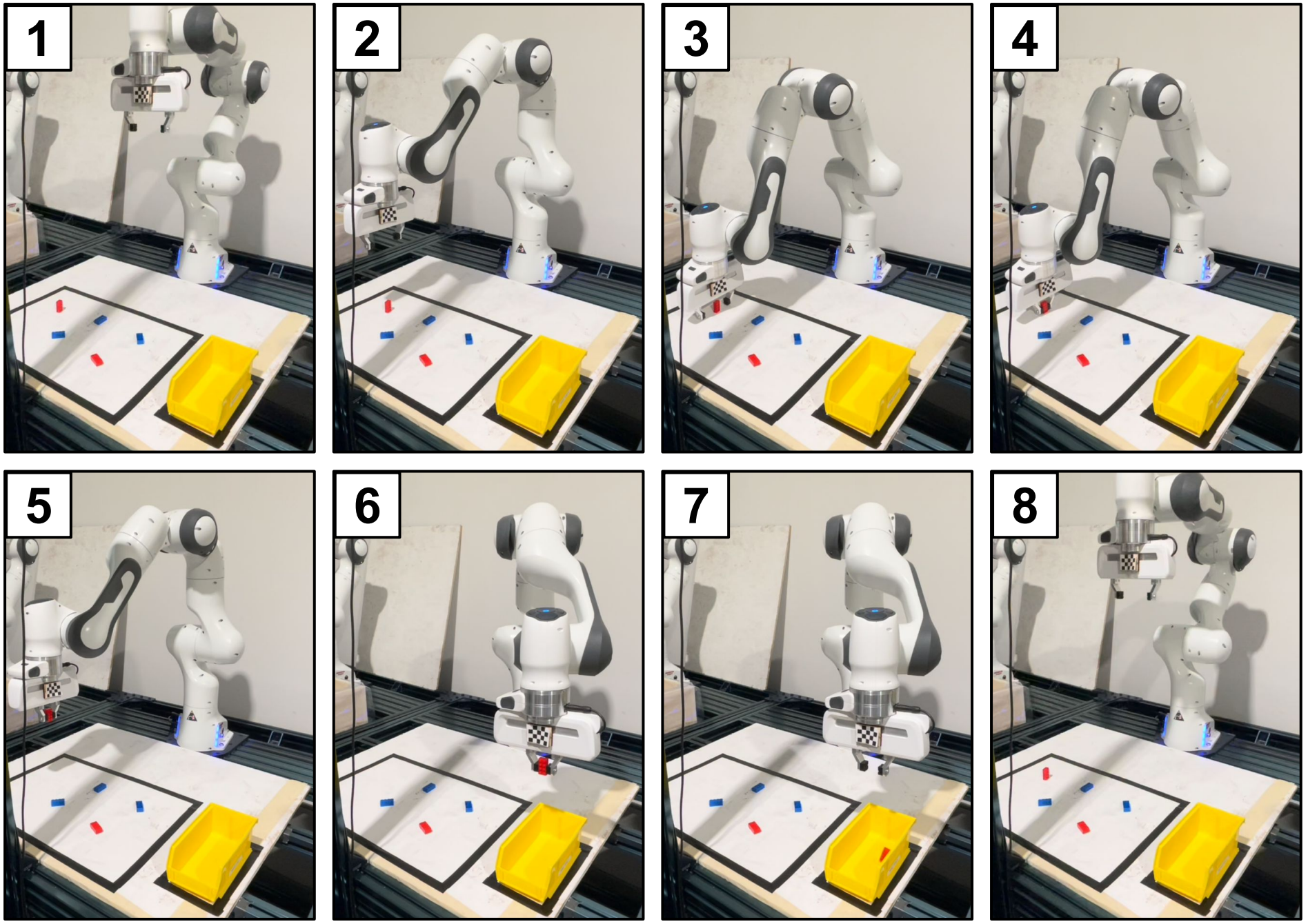
8. Open gripper



Manipulation Methods

1. Begin from home
2. Select target
   a. Wait until detection: all red, then all blue
3. Intermediate target pose
4. Brick pose
5. Close gripper
6. Intermediate target pose
7. Move to kit
8. Open gripper
9. Repeat!
   a. Until all block orders filled


1
2
3
4
5
6
7
8

Demonstration!

Functional evaluation

1. Basic functionality with **easy bricks**
2. Robust functionality with **multi-sized bricks**

Extension for robustness and cobot

3. Picking in **clutter**
4. **Cobot**: live block dropping + re-moving


4X SPEED - CLUTTERED WORKSPACE, CLEAN SEGMENTATION

Evaluation

- System can robustly **detect** and **locate** relevant blocks 
- System can accurately and consistently **grasp target** blocks 
- System is able to drop blocks into kit with **rare loss or misses** 
- System can **assemble** requested kits **quickly** and **accurately** 

Future Work

- Add **inspection** step/logic to verify grasp
- **Online target planning**; grab color(s) as available
- Increase the number of **recognizable objects/colors**
- Add **size** and **shape** for object recognition
- Construct workspace part **with human**

Thank You!

Questions?

Prof. Kroemer

MRSD Peers &TAs

Team 8

Non-Autonomous Manipulator

Ole Kirk Kristiansen

Hi All,

I hope your final preparations are going well for the SVS. We will be having the final presentations next week (last week of class), with the final reports and final videos due the following Friday. The presentation should be around 10 minutes long. The presentations should cover the following topics (points given in brackets).

Motivate the overall problem [1]
Highlight 2-3 key challenges [1]
Overview of approach [2]
Methods implemented [2]
Demo/Evaluation [1]
Future work (until report and beyond) [2]
Simple video [1]

The final reports should be around 6 pages long and cover similar topics to the presentation. The reports and videos will be due May 6th to give you a bit more time to work on the project and create a nice video.

Motivate the overall problem [2]
Highlight 2-3 key challenges [3]
Overview of approach [3]
Methods implemented [3]
Demo/Evaluation [3]
Future work [1]

Final Video [5]

The final video does not need to be self-contained or require voiceover, although you can if you want. It should be somewhat polished though (e.g., use a tripod if possible) and demonstrate the overall system. Try to show variations that the system can handle if possible.

Times for the individual group presentations next week will be similar to those of the update meeting:

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Tuesday:

3:05 - team 1
3:17- team 2
3:29- team 4
3:41- team 11
3:53- team 12
4:05- team 14
4:17- team 10

Thursday:

3:05 - Team 5
3:17- Team 9
3:29- Team 3
3:41- Team 8
3:53- Team 6
4:05- Team 7