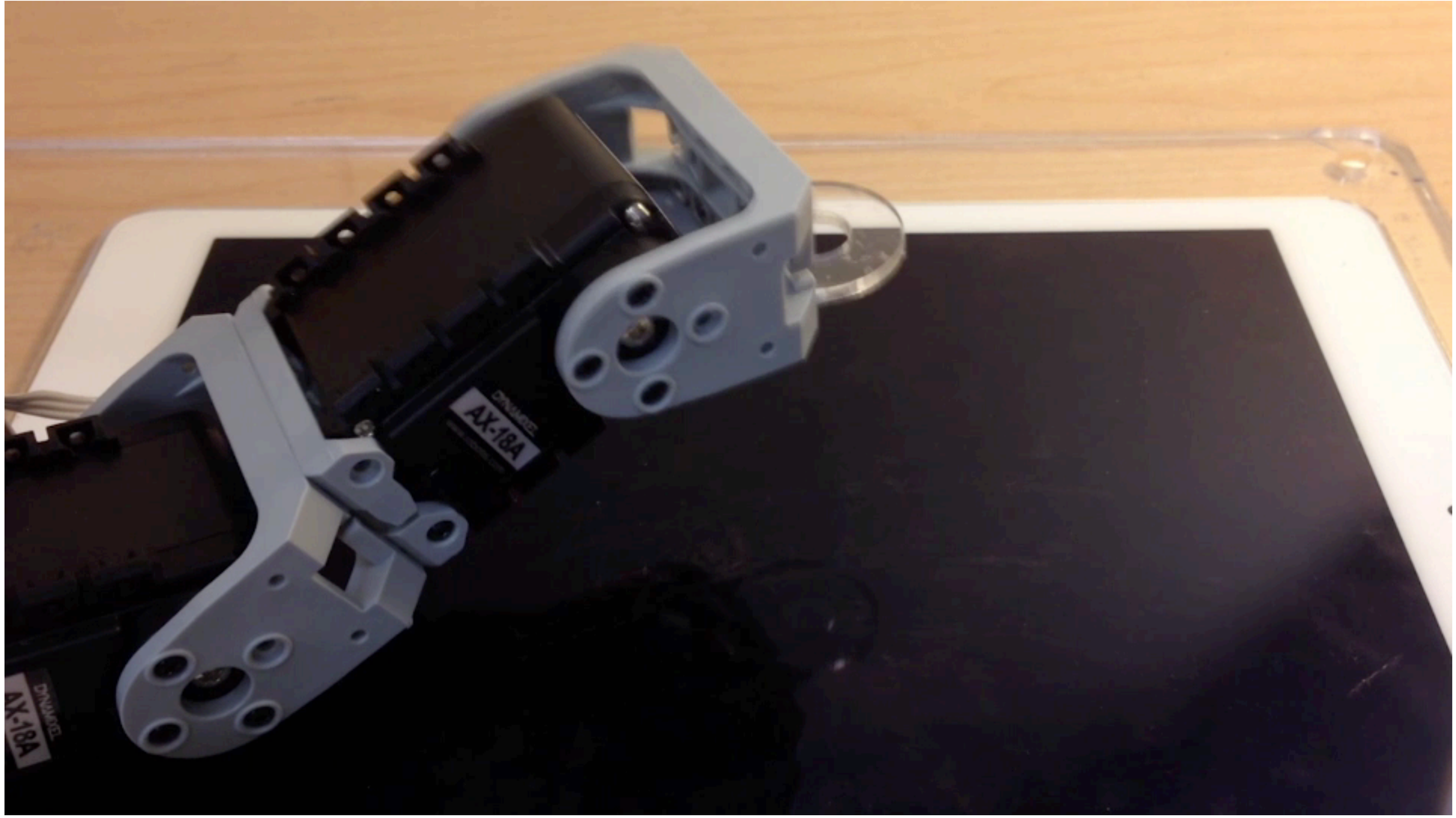
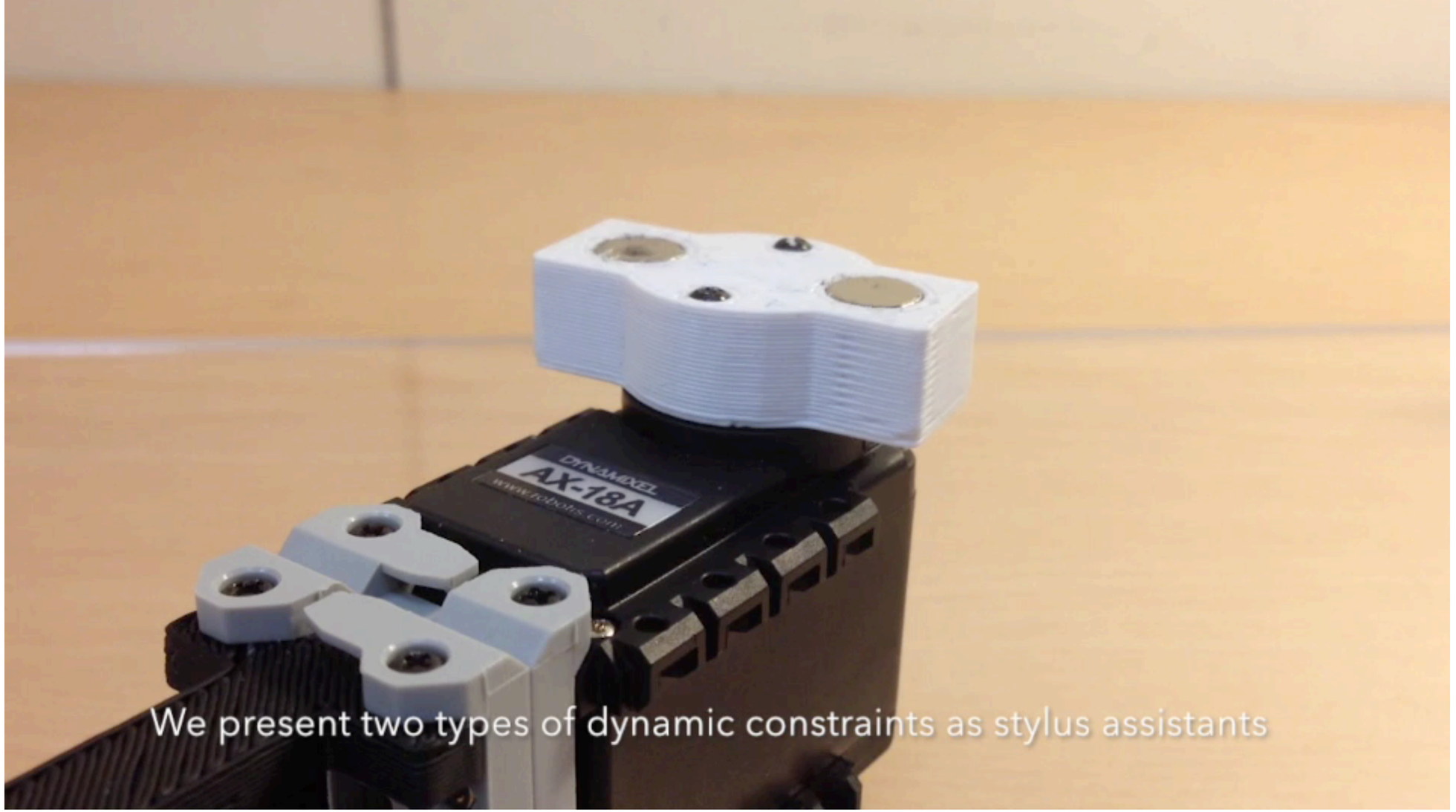
Stylus Assistant: Designing Dynamic Constraints for Facilitating Stylus Inputs on Portable Displays

Long-Fei Lin, **Shan-Yuan Teng**, Rong-Hao Liang, Bing-Yu Chen

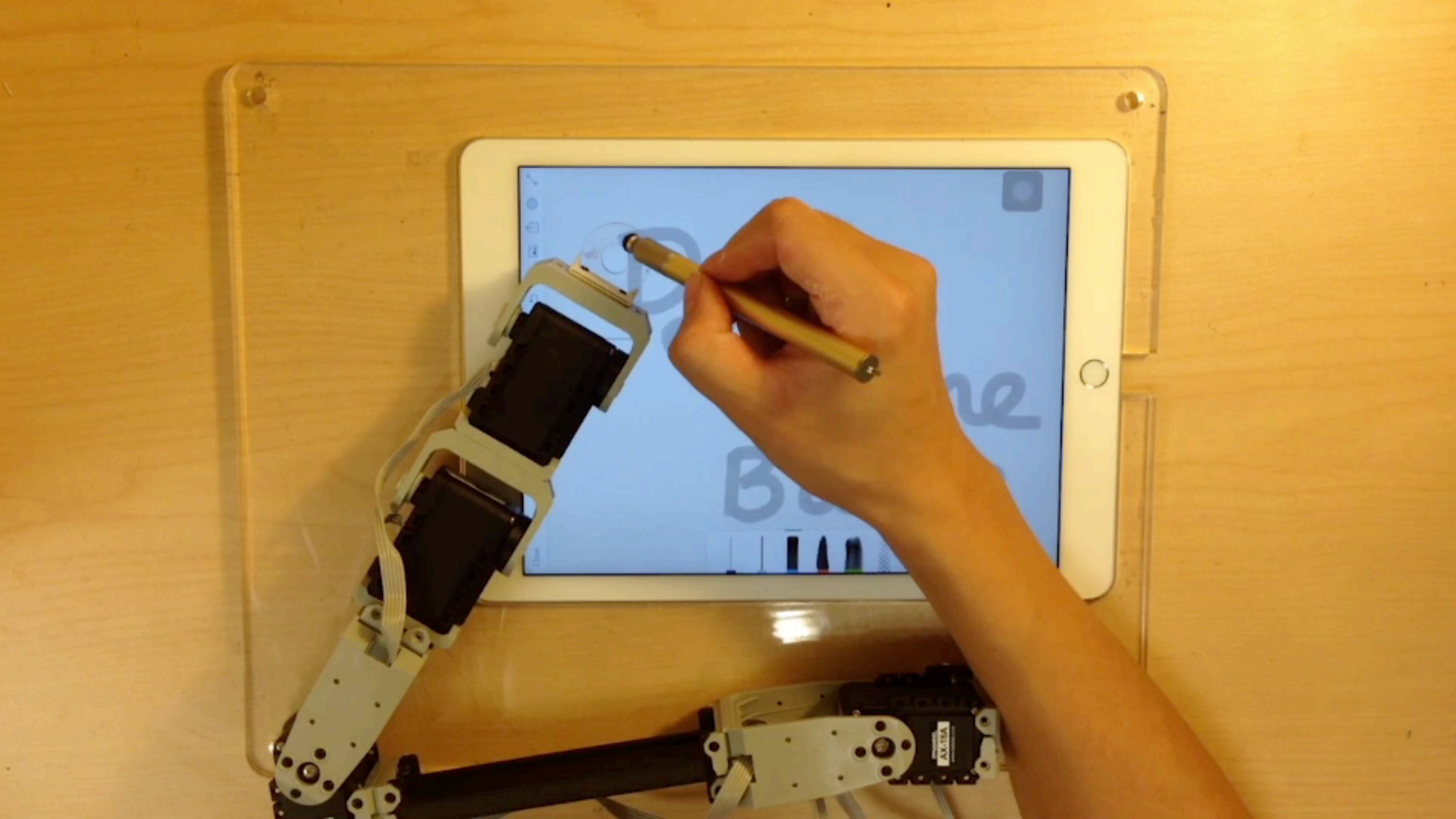
National Taiwan University



DynaFrame: Around-Display Constraint



DynaBase: Back-of-Display Constraint



Introduction

Portable displays

+

stylus input

only visual guidance

no force feedback

apple.com

Related Work

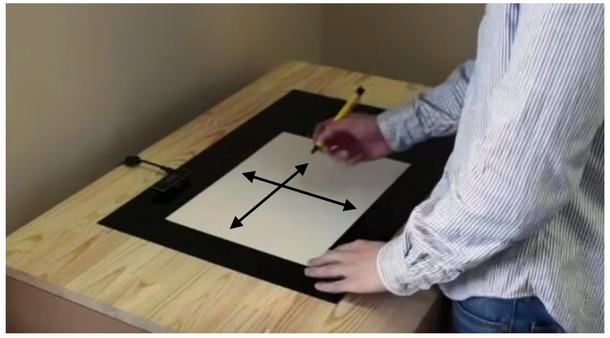
[Nakagaki et al., UIST'15]

LineFORM: Actuated Curve Interfaces for Display, Interaction, and Constraint

[Yamaoka and Kakehi., UIST'13]

dePENd: Augmented Sketching System Using Ferromagnetism of a Ballpoint Pen

Not grounded to the display.



Not suitable for portable displays.

provide enough force feedback
for guidance on portable displays
in a reasonable form

Design

1) As small occlusion as possible.

nearby the stylus tip / remaining area

2) Effectiveness.

precision / reaction time

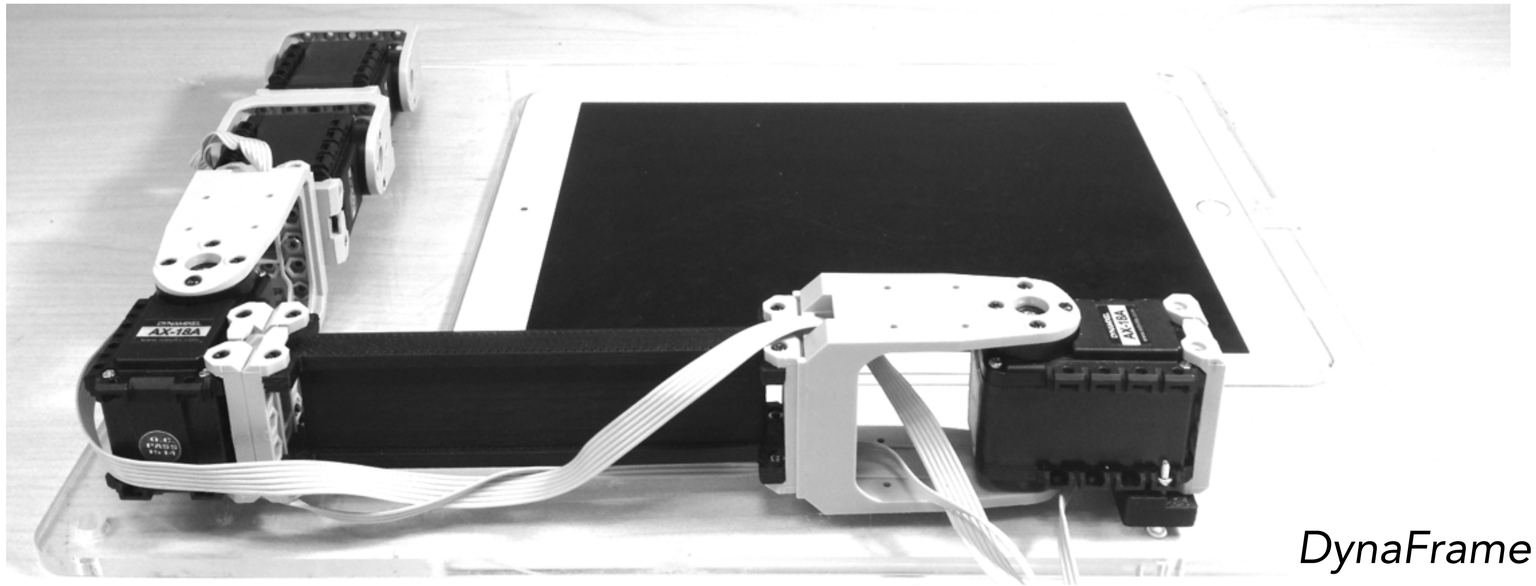
3) Expressiveness.

position / speed / pressure

Guidance mechanism *above* the display

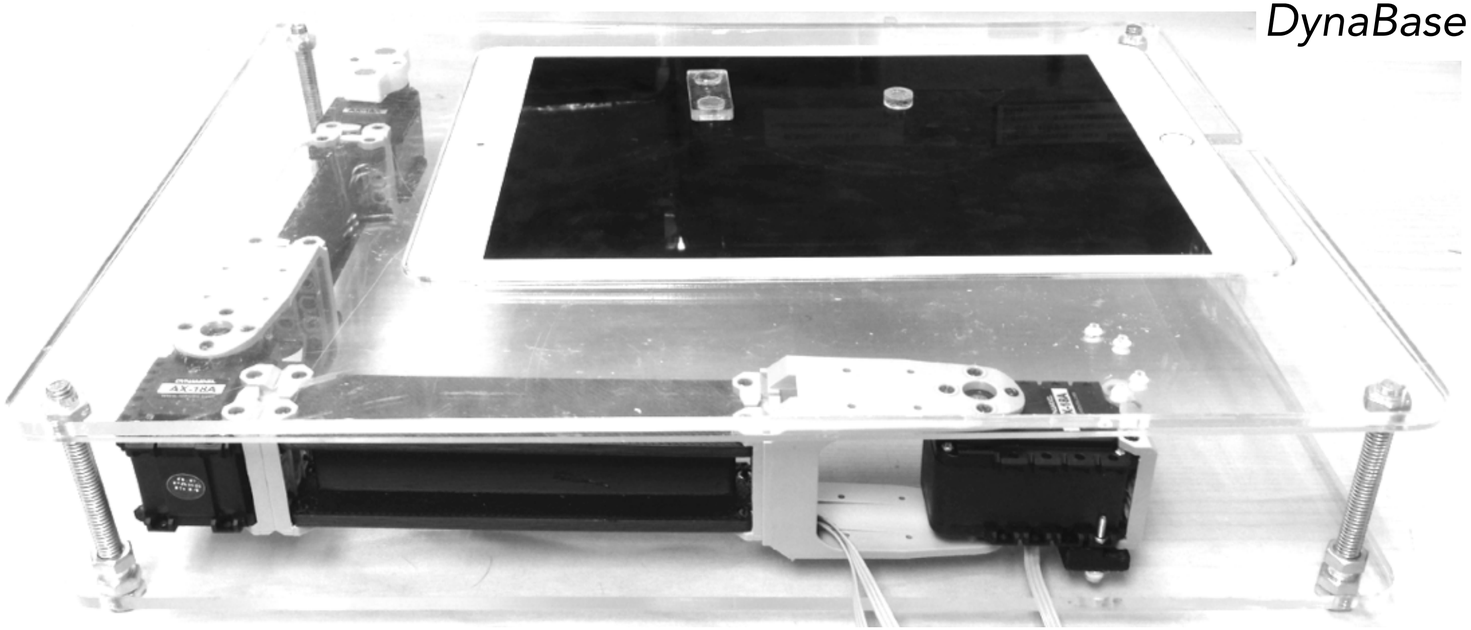
Guidance mechanism *under* the display

Around-display



DynaFrame

Back-of-display



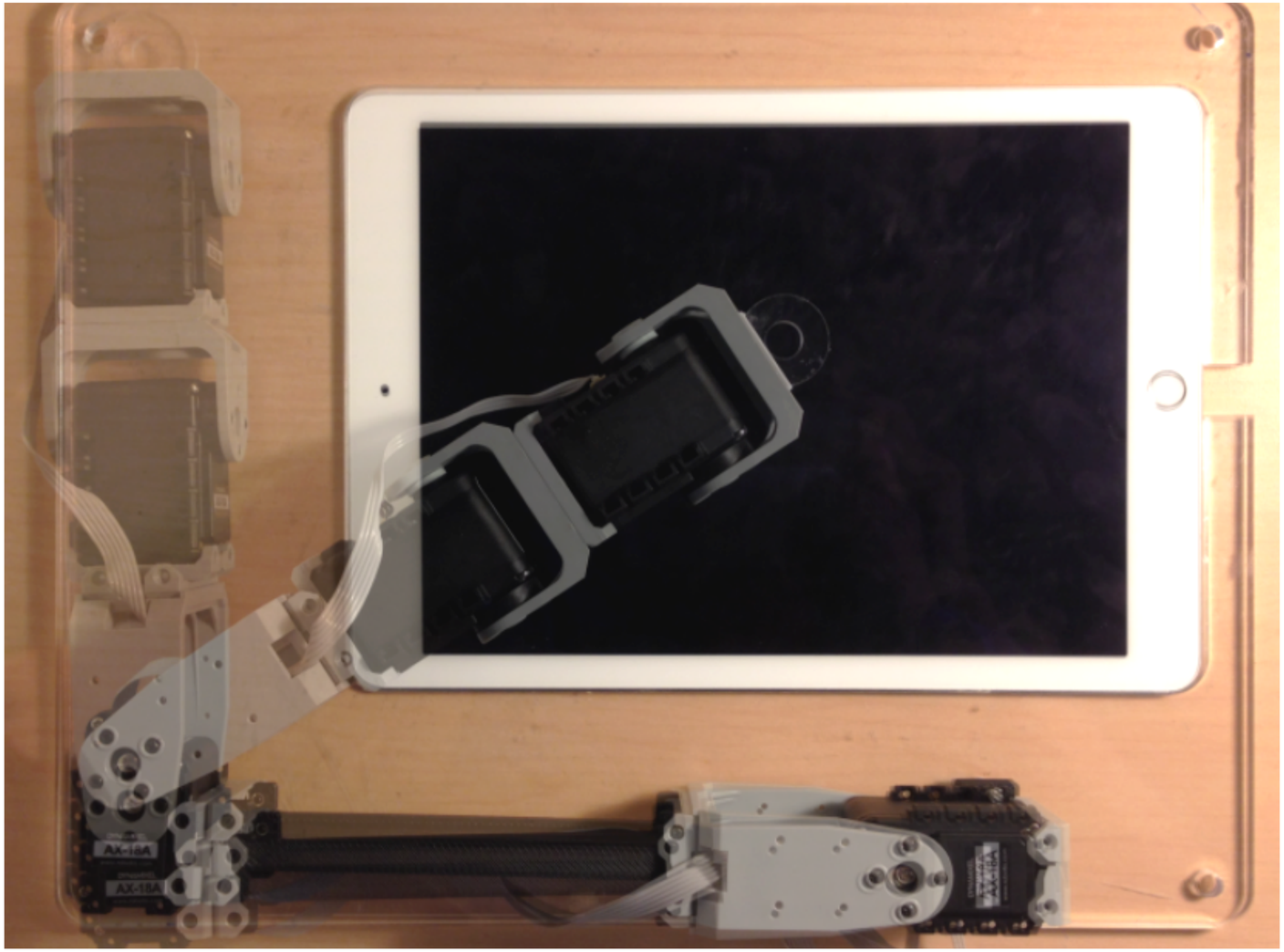
DynaBase

Dynamixel AX-18A

No-load Speed: 97rpm ,0.103 sec/60°
Size: 32 x 50 x 40mm
Stall Torque: 18.3 kg·cm
Resolution : 300°/1024 = 0.29°

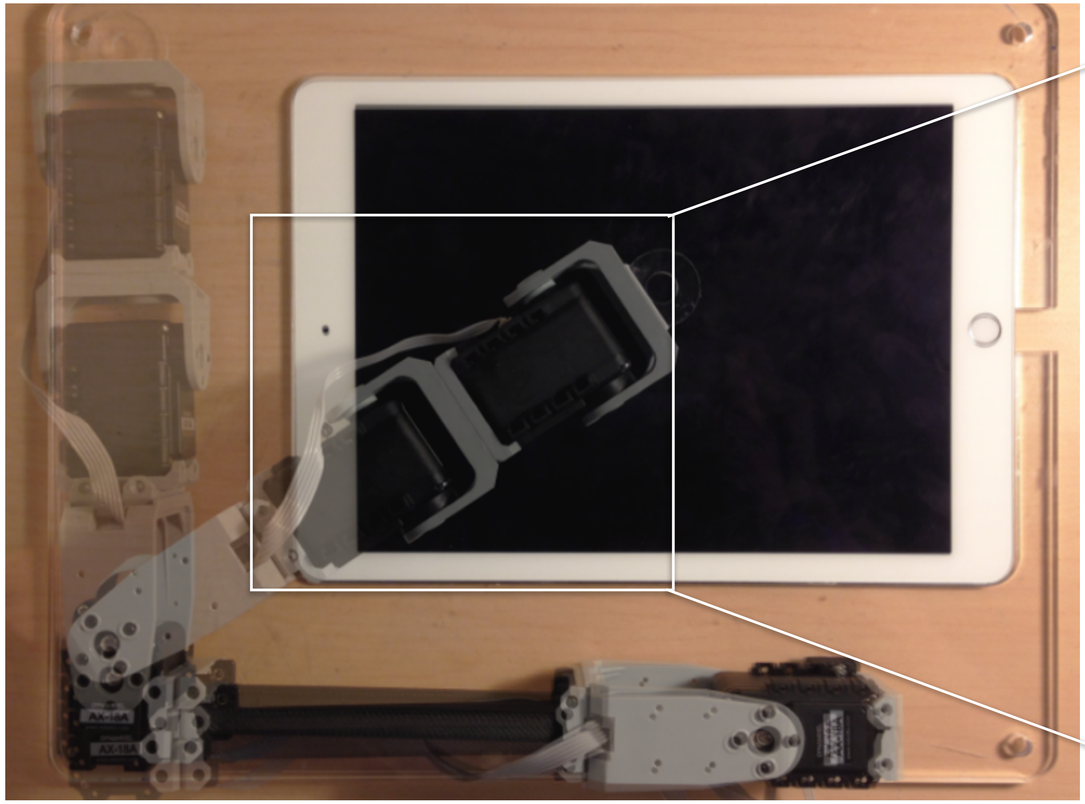
DynaFrame

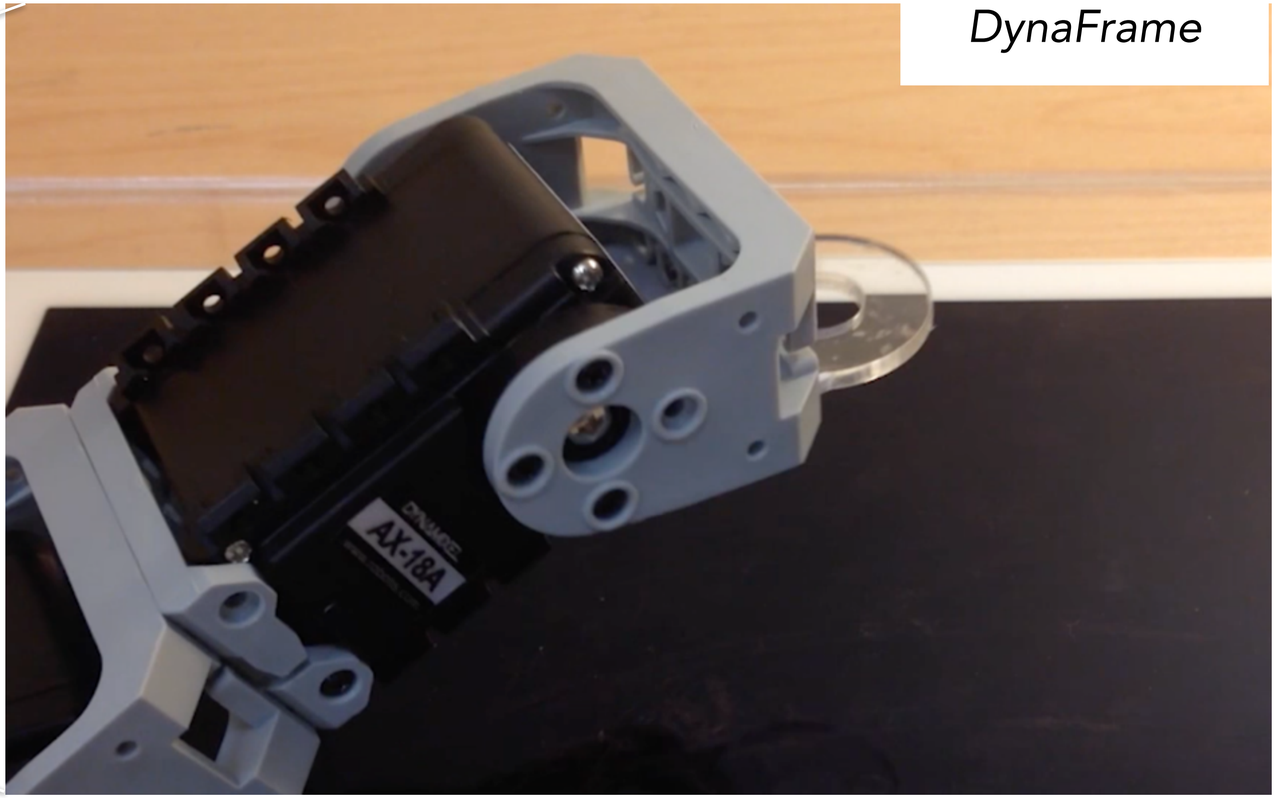
Around-display constraint



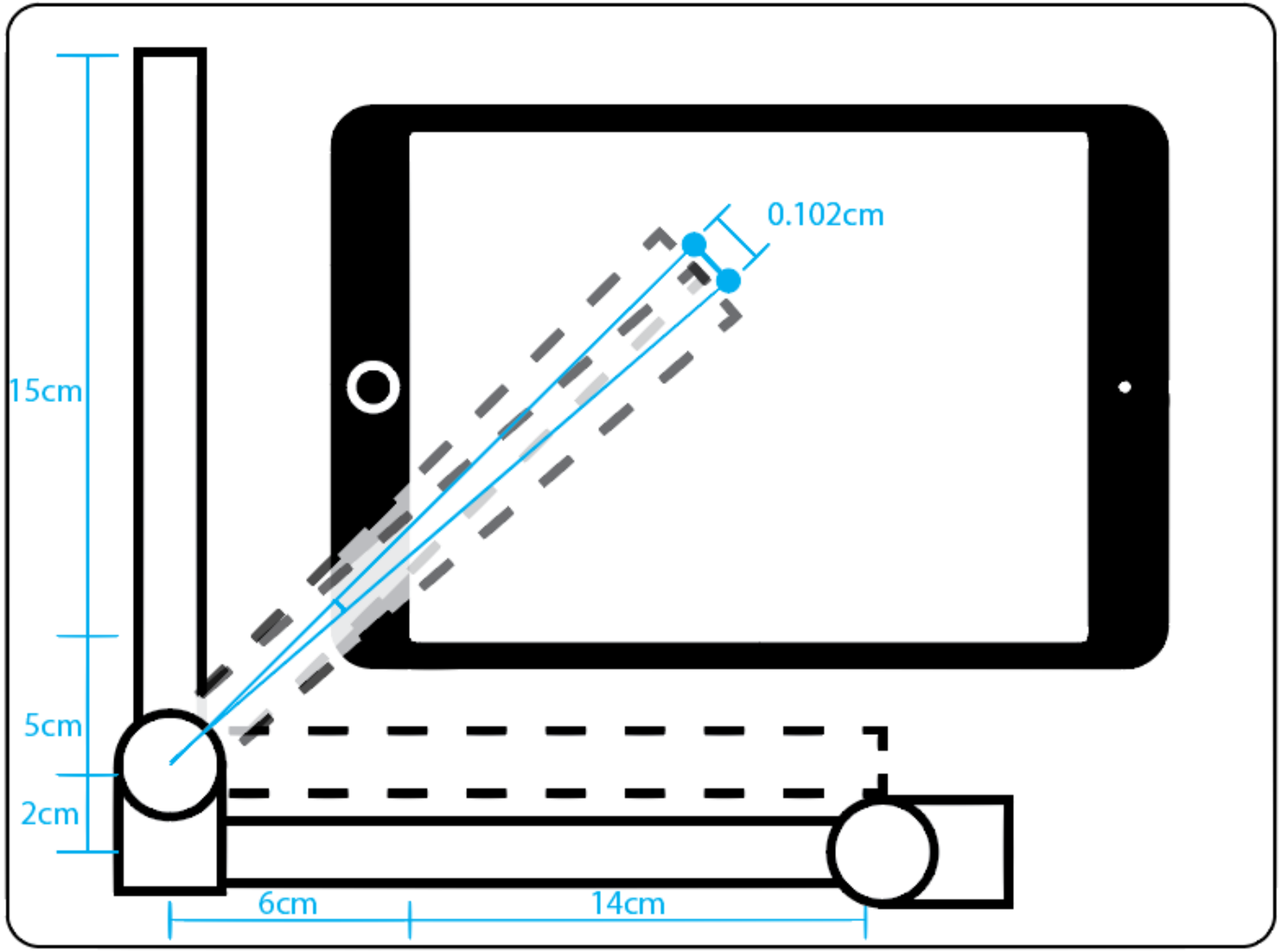
DynaFrame

Around-display constraint





2D Stylus Position: Inverse Kinematics (IK)



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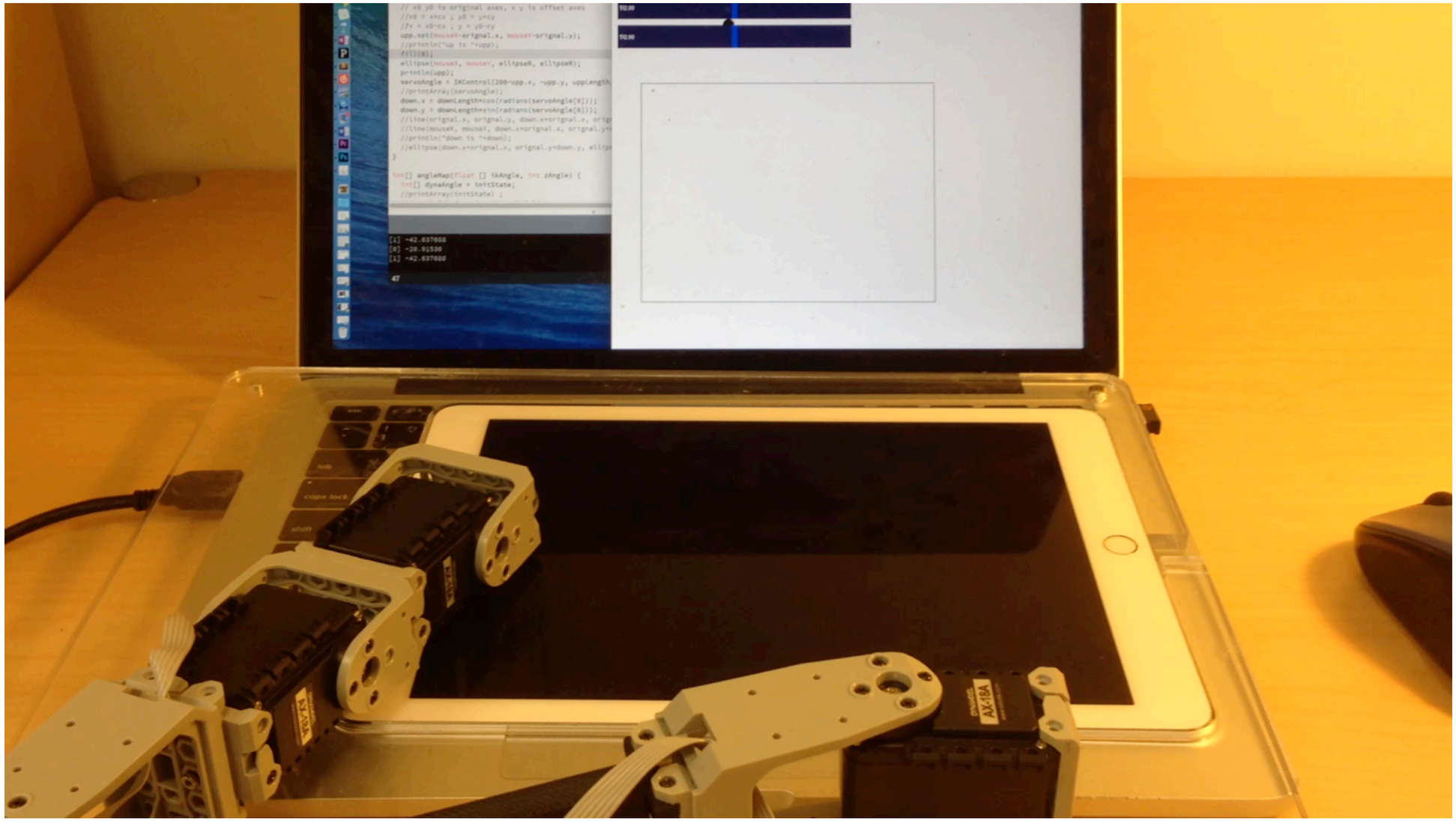
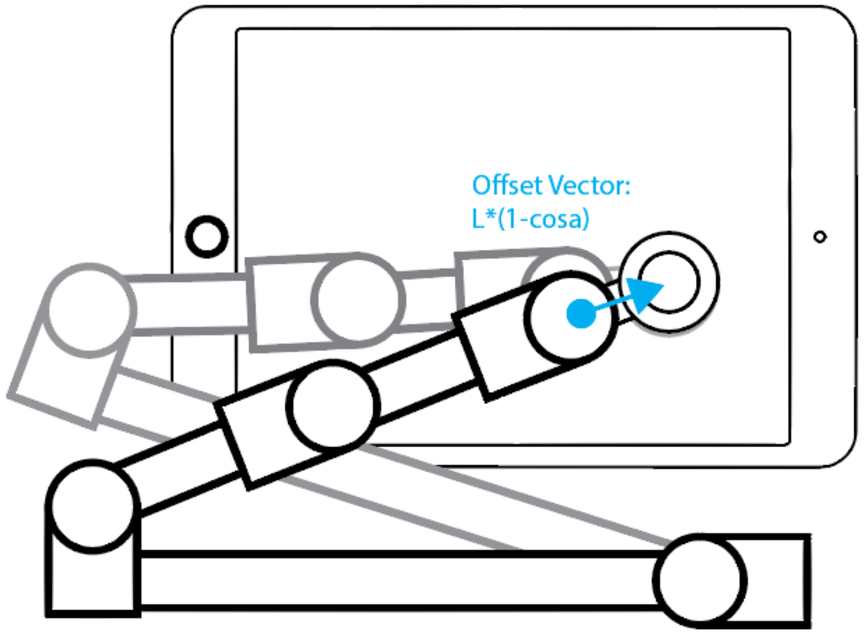
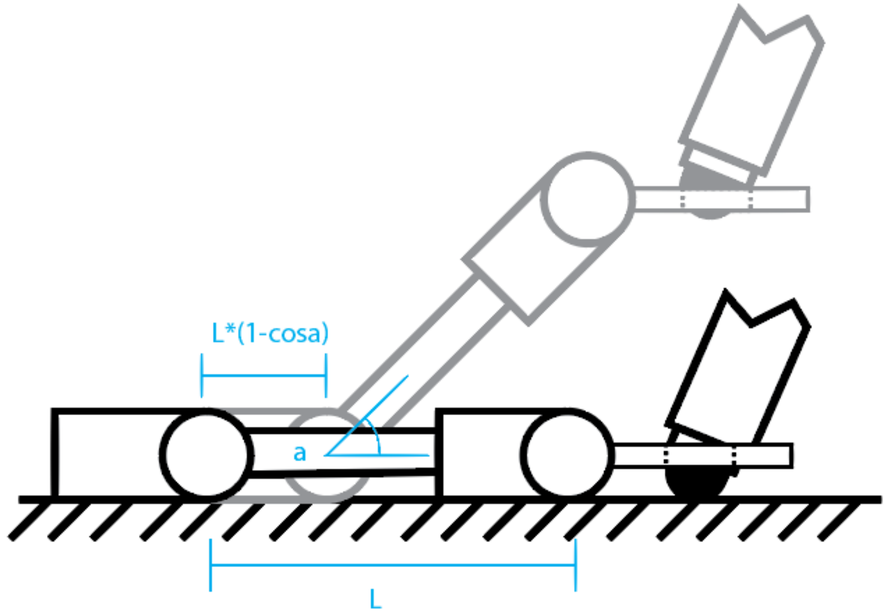
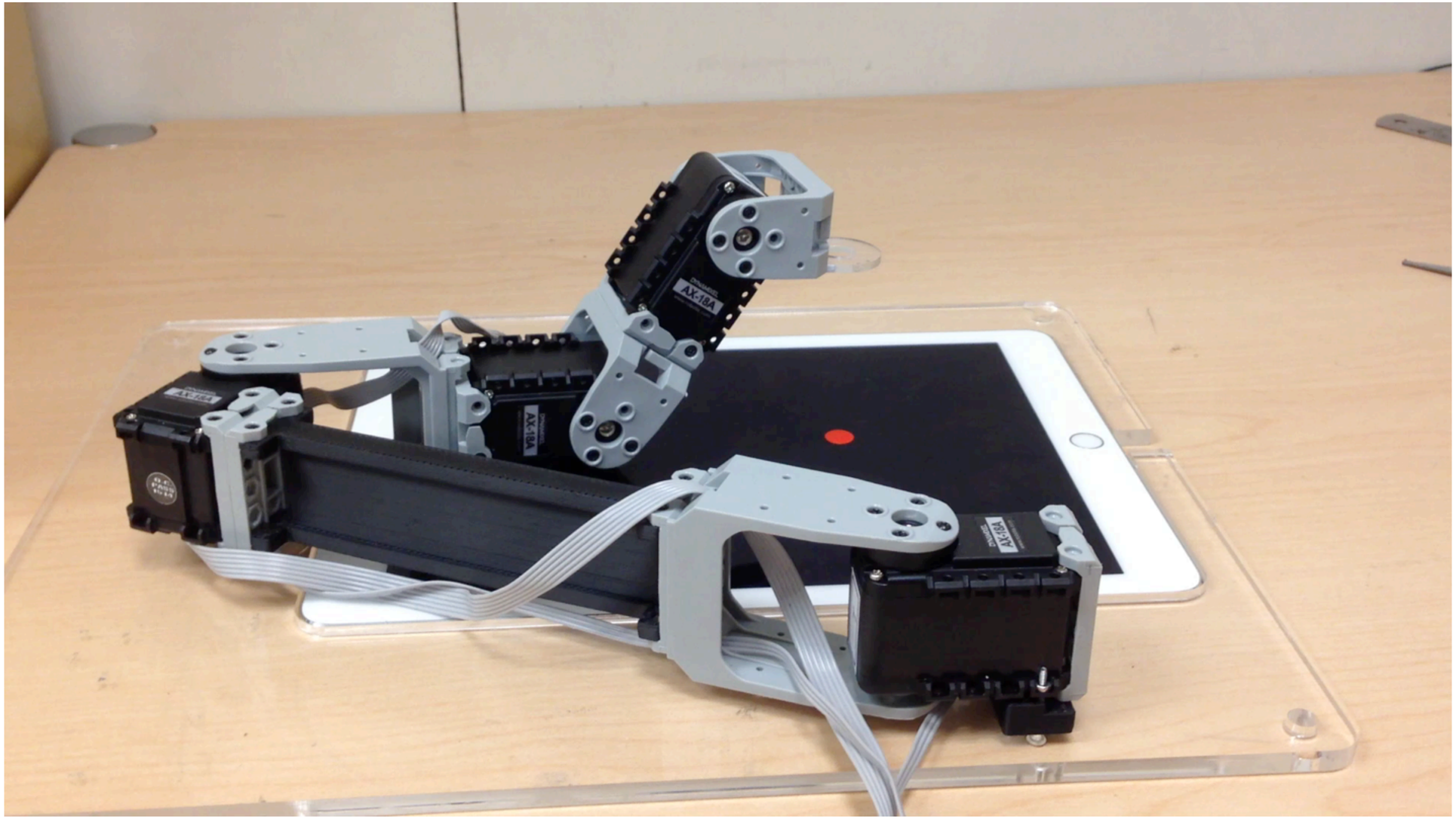


Toward 3D:

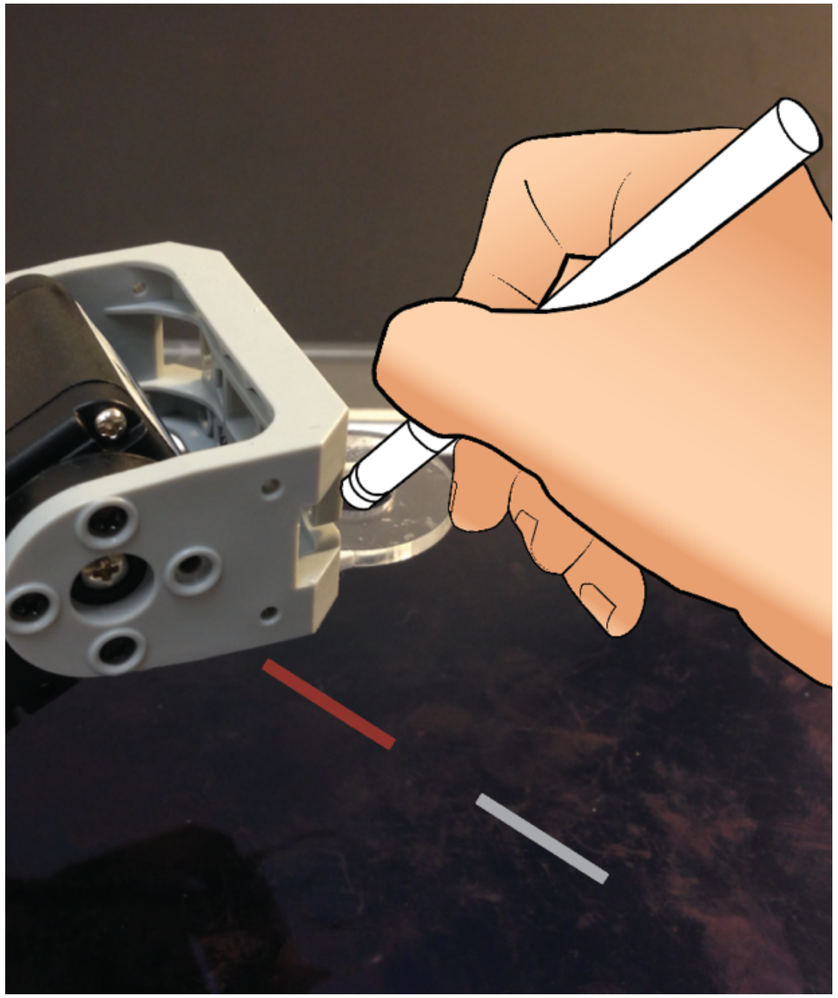


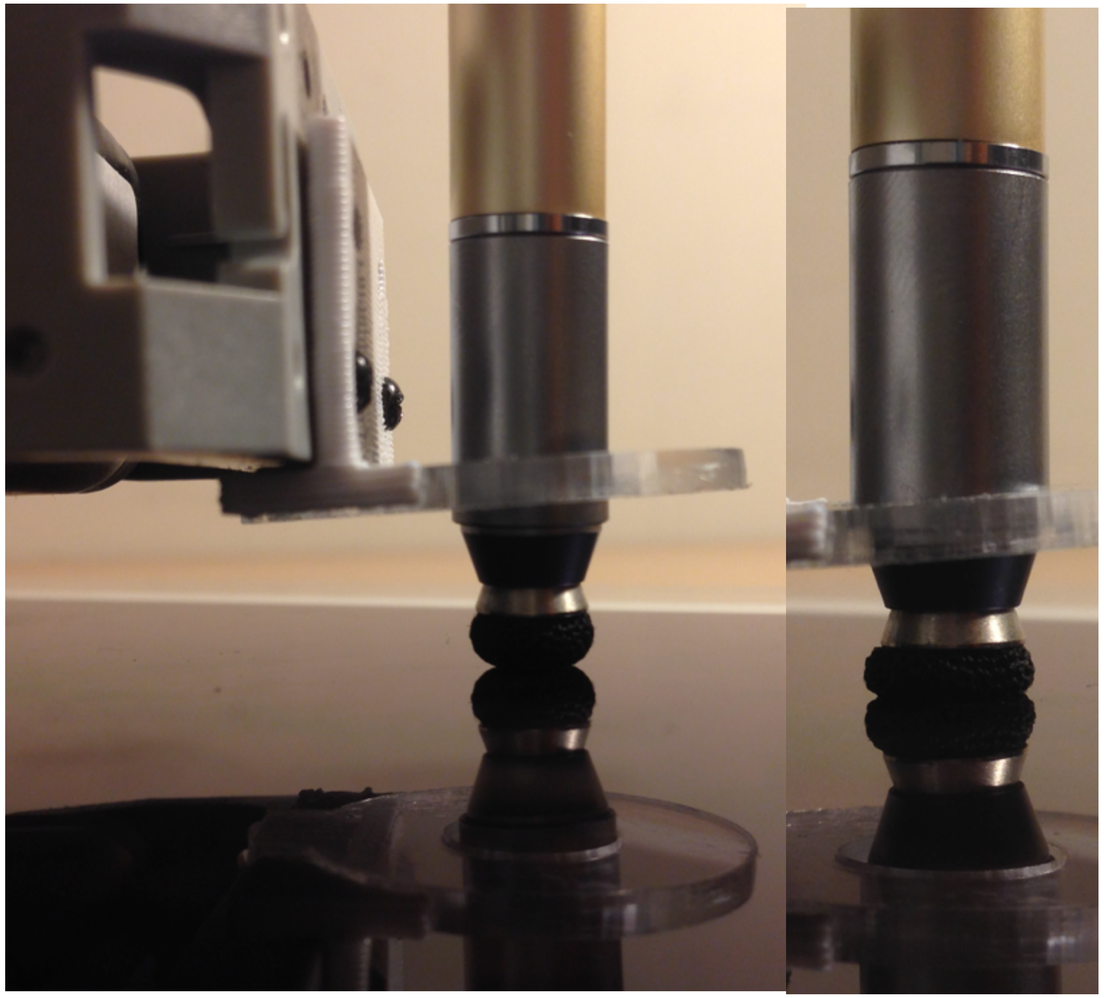


Toward 3D:

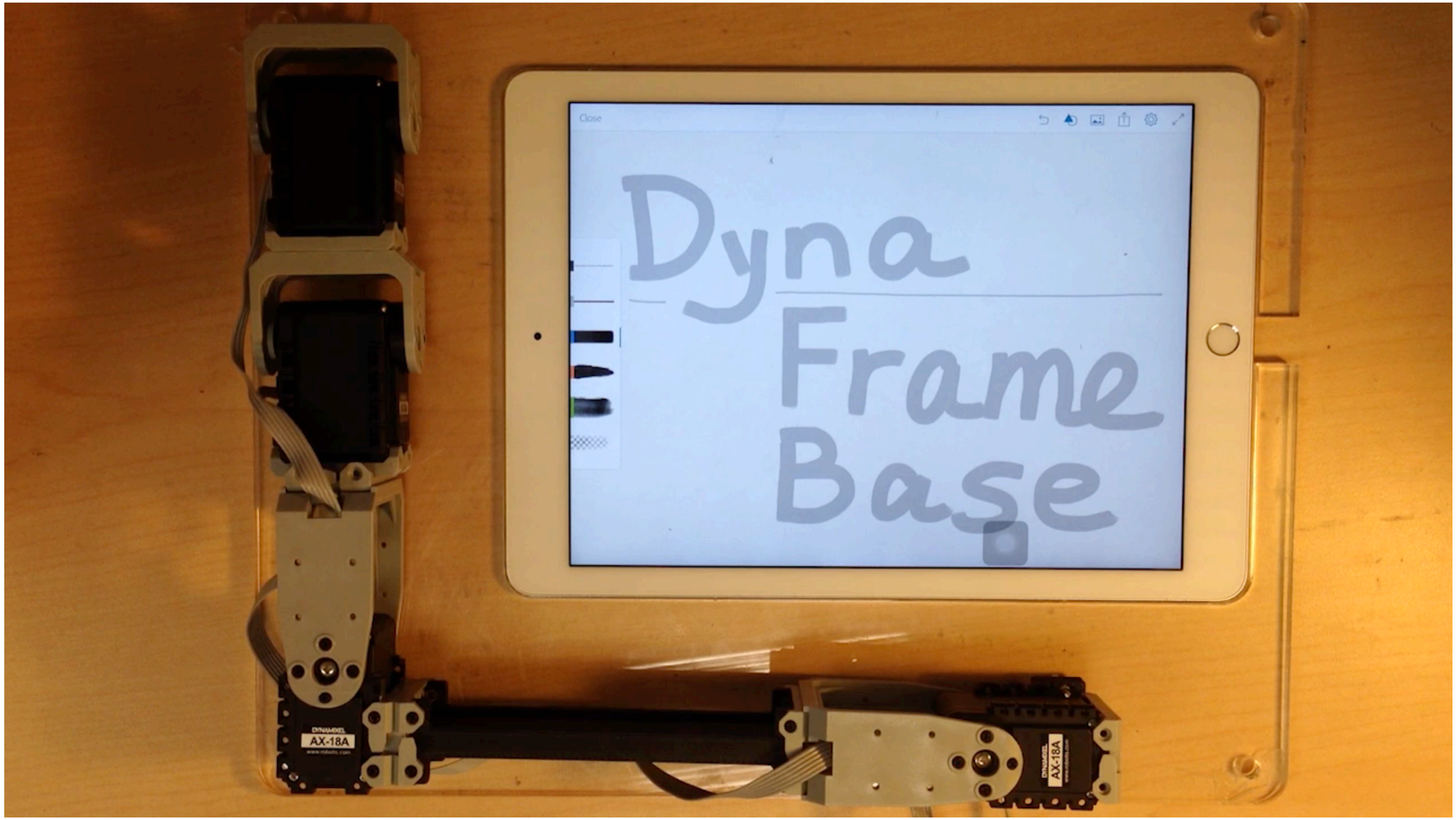


Interaction Procedure guidance

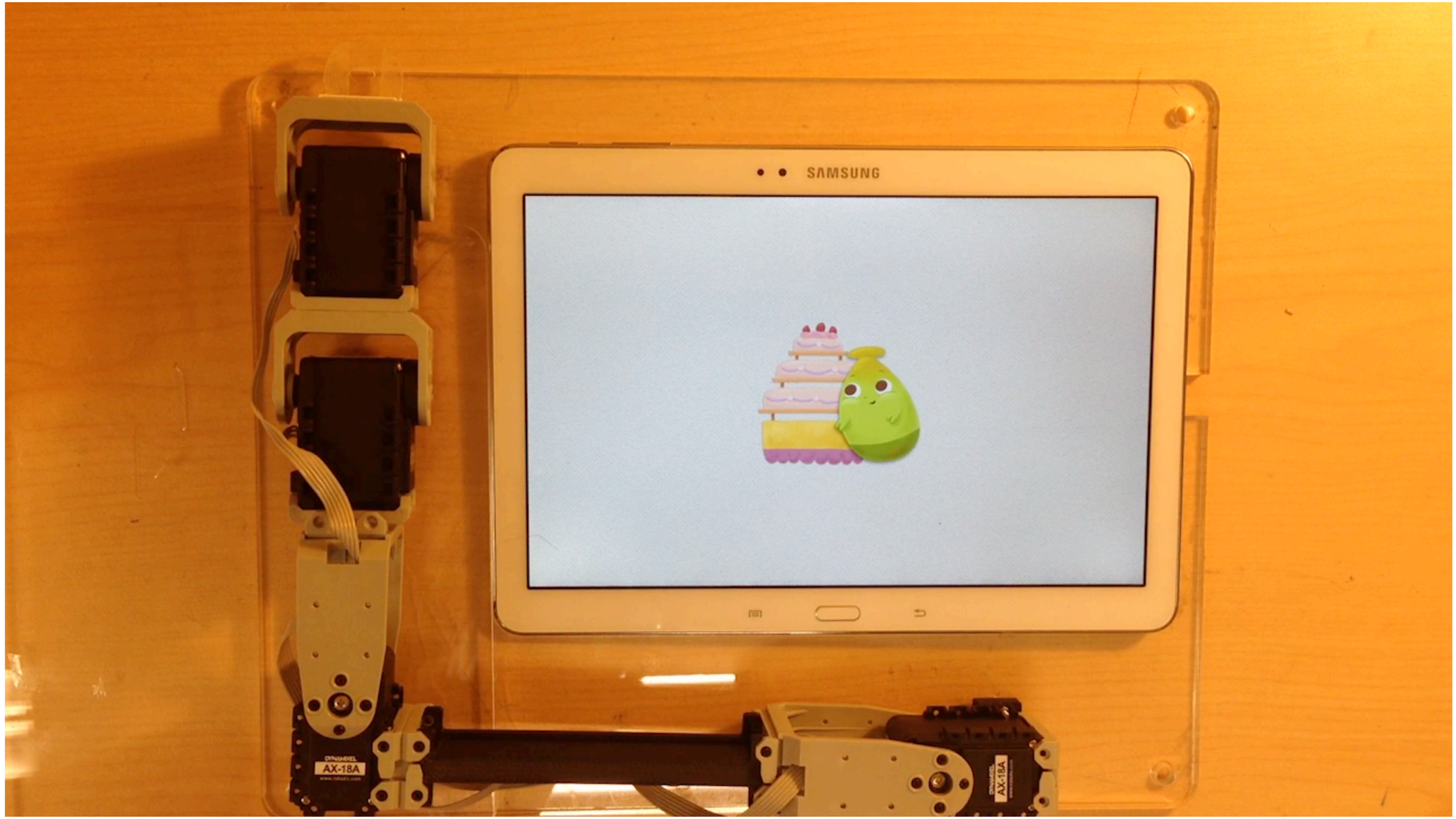




Application Writing



Application Playing



DynaFrame

Around-display constraint

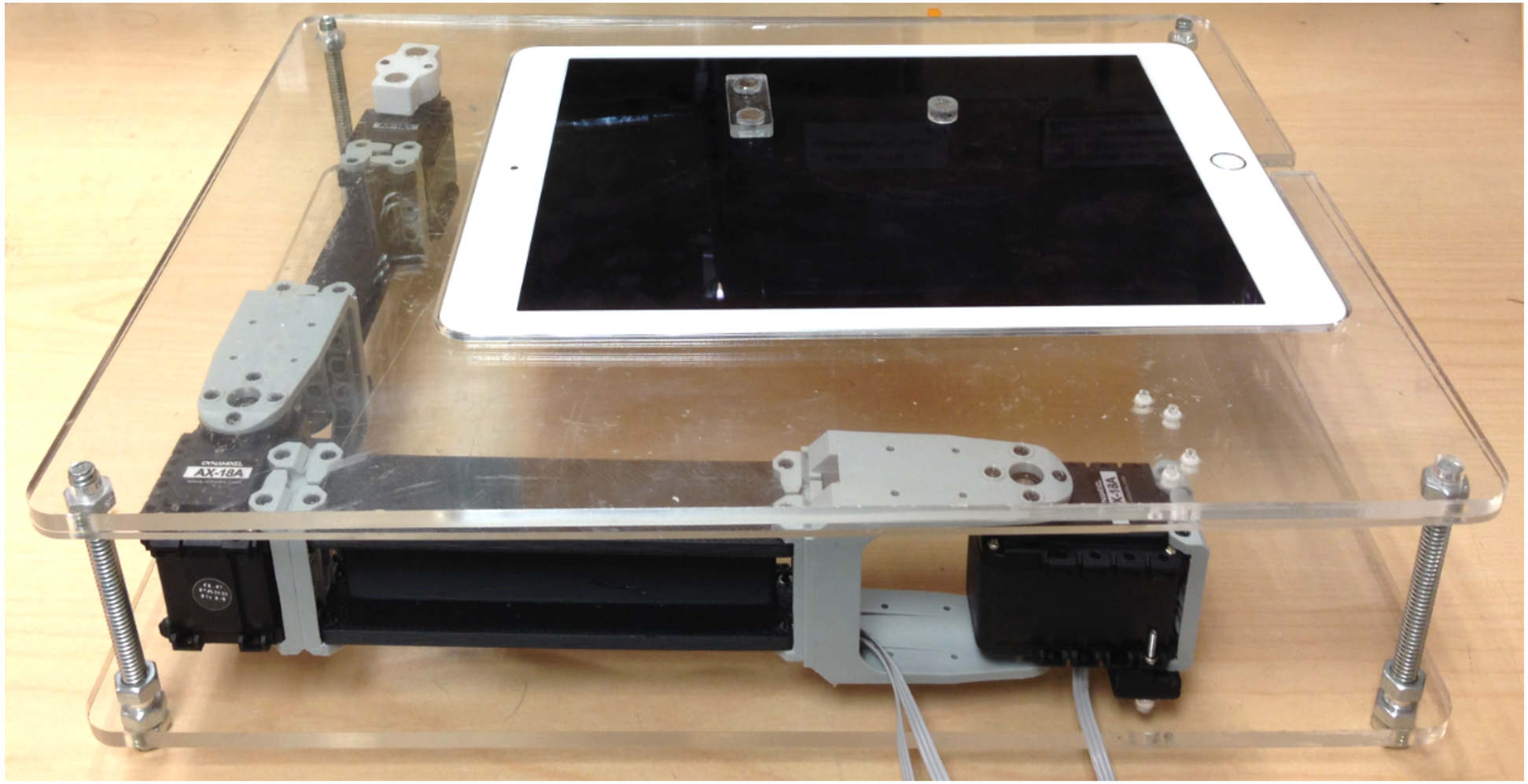
3D guidance
with procedure

Good visibility

Occlusion

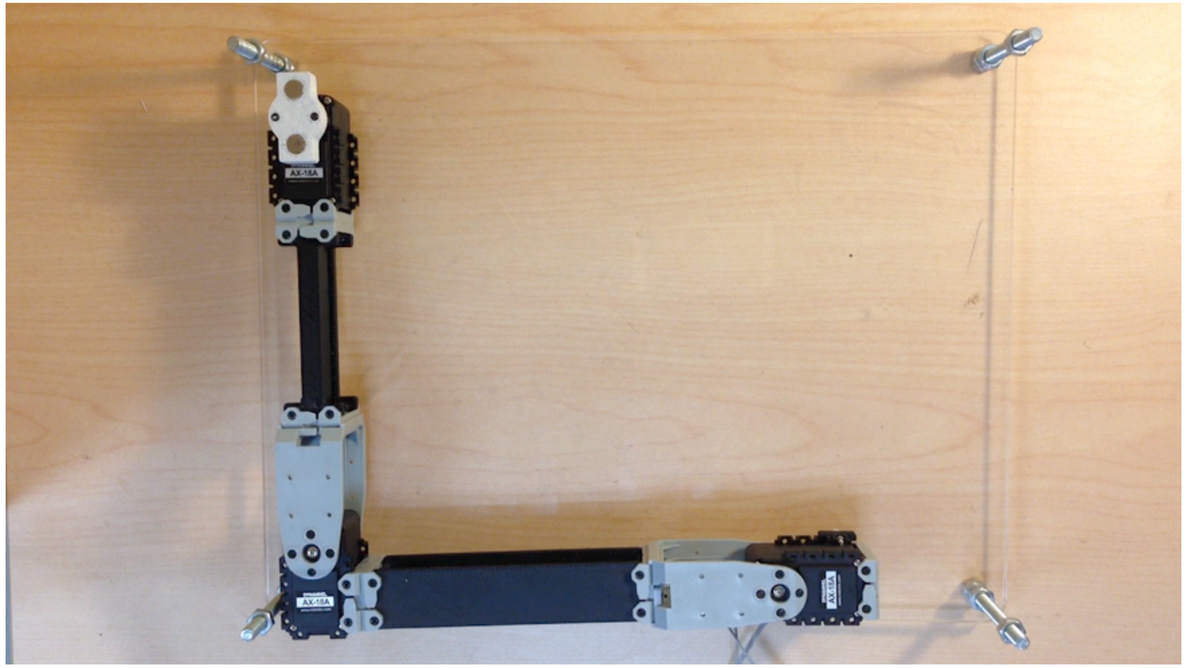
DynaBase

Back-of-display constraint



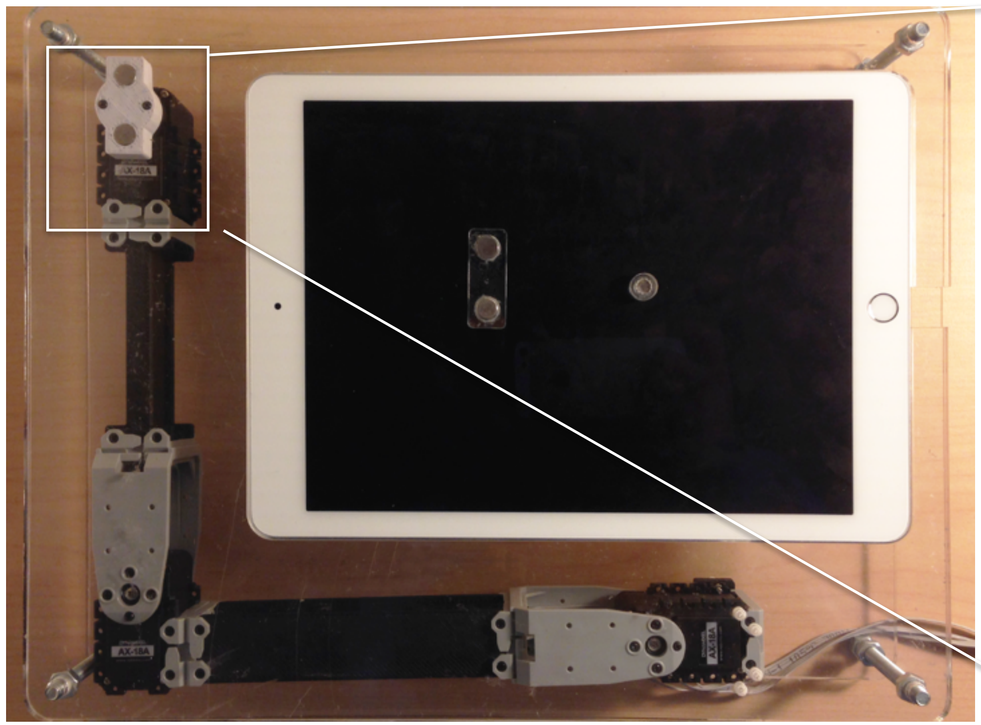
DynaBase

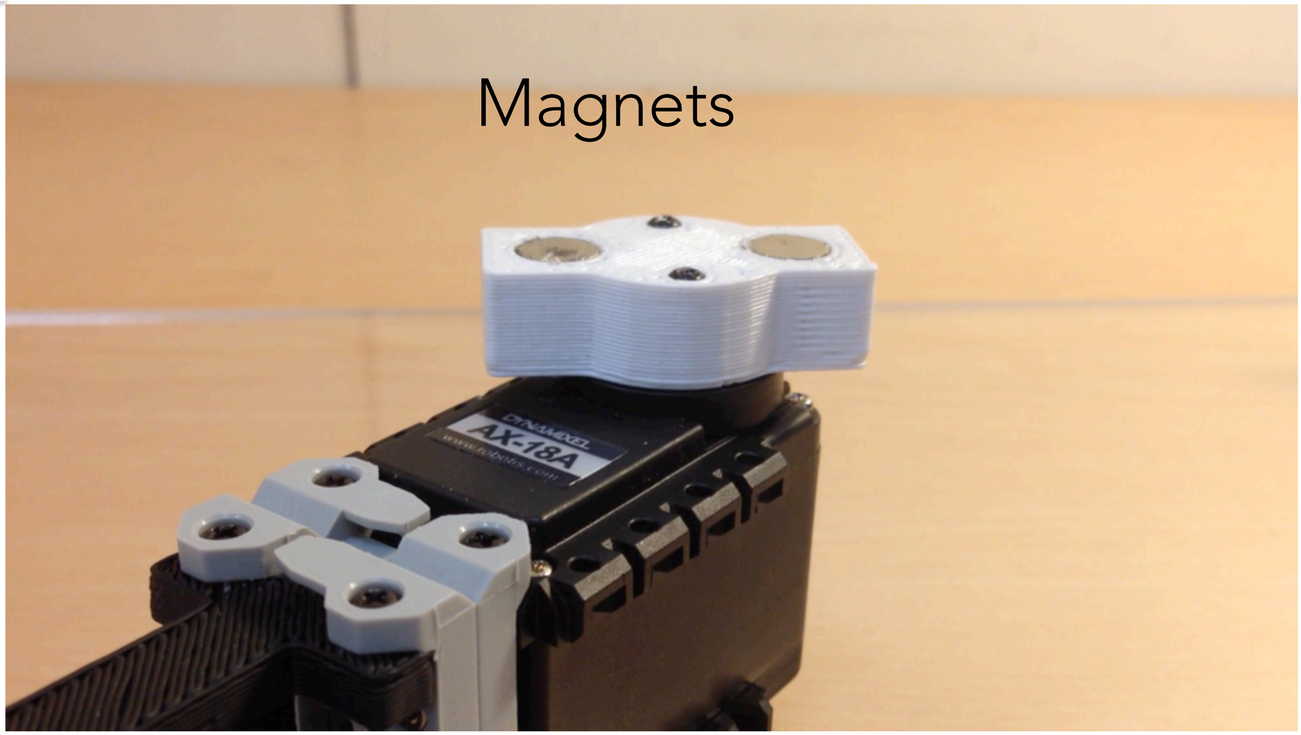
Back-of-display constraint



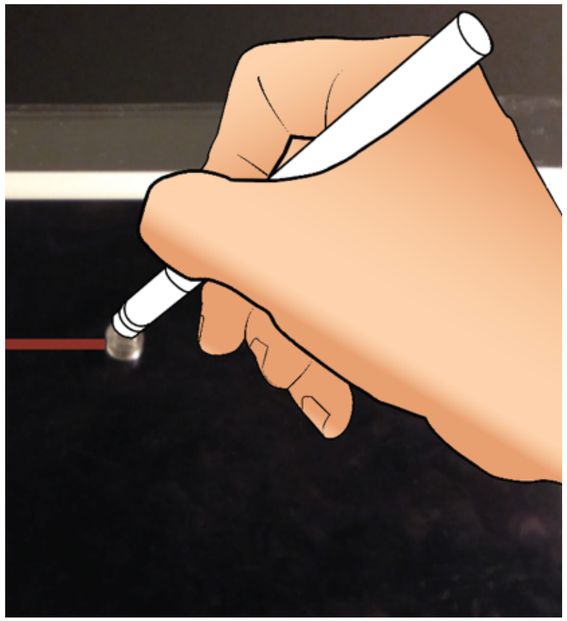
DynaBase

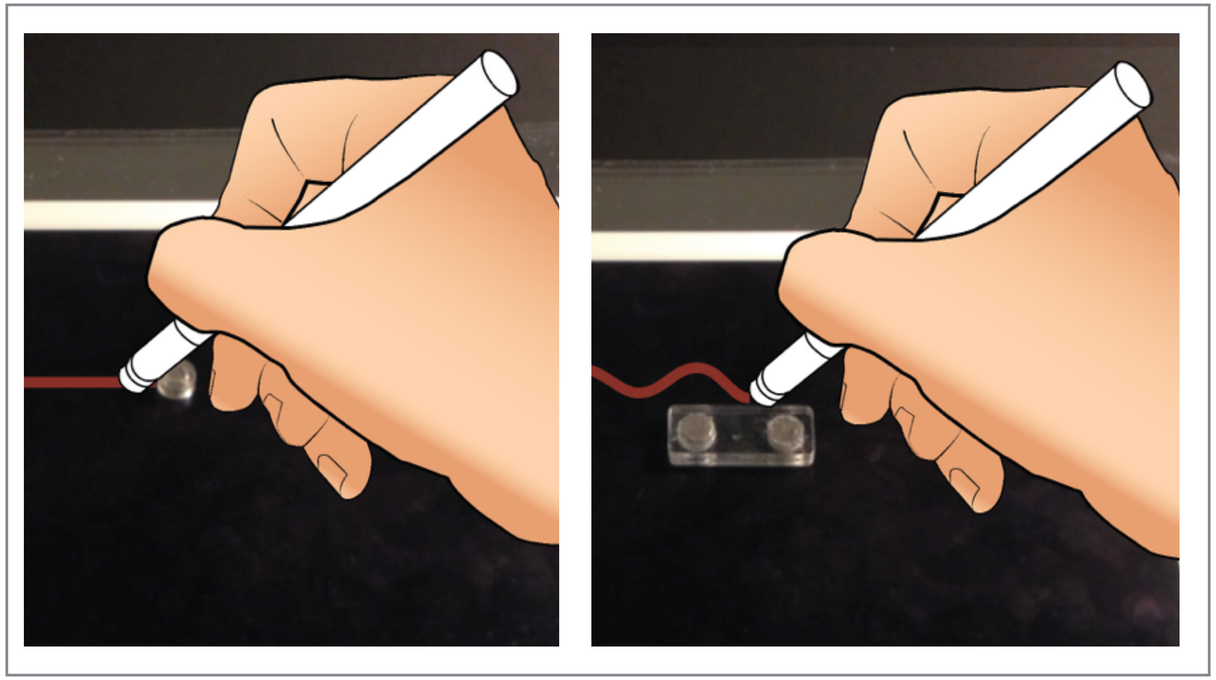
Back-of-display constraint





Interaction

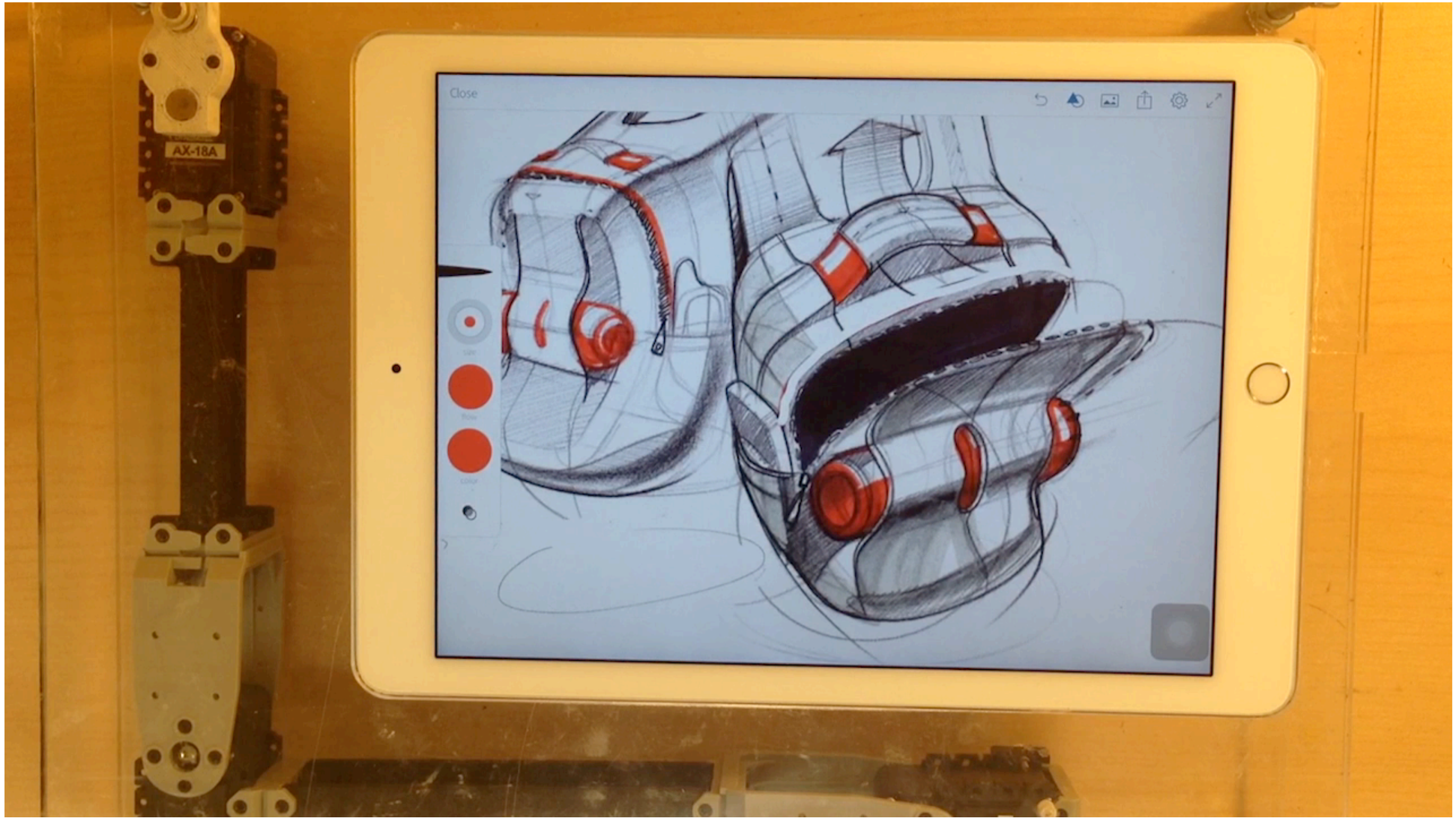




Hard constraint

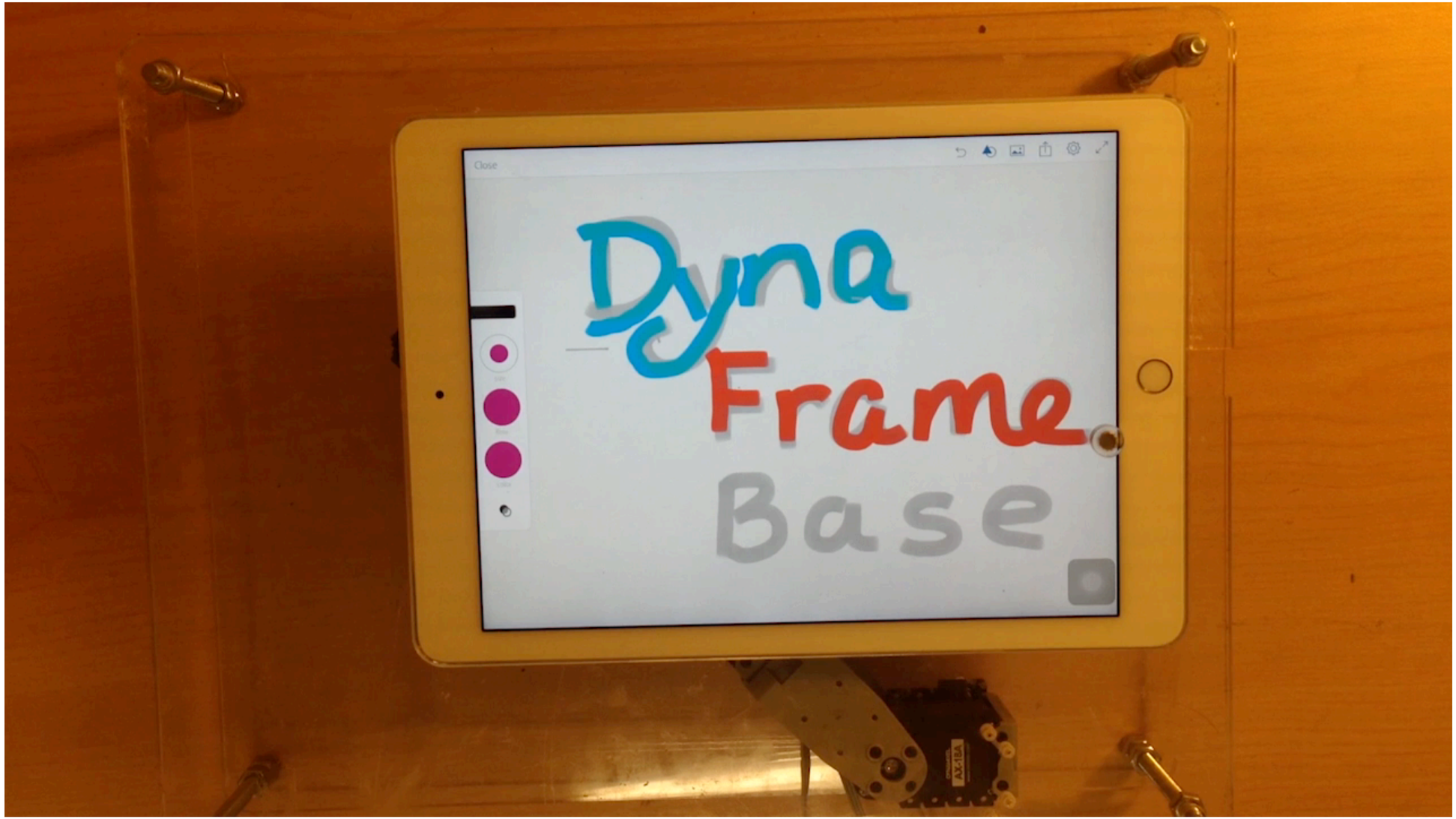
Soft constraint

Interaction Hard constraint

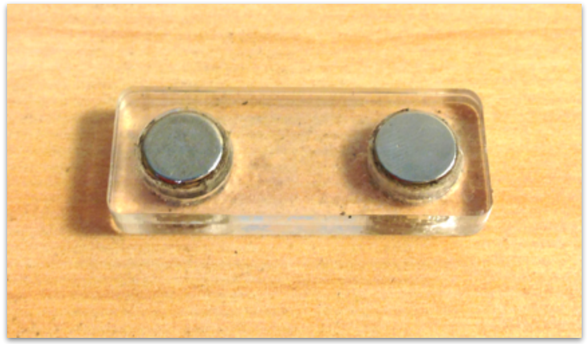


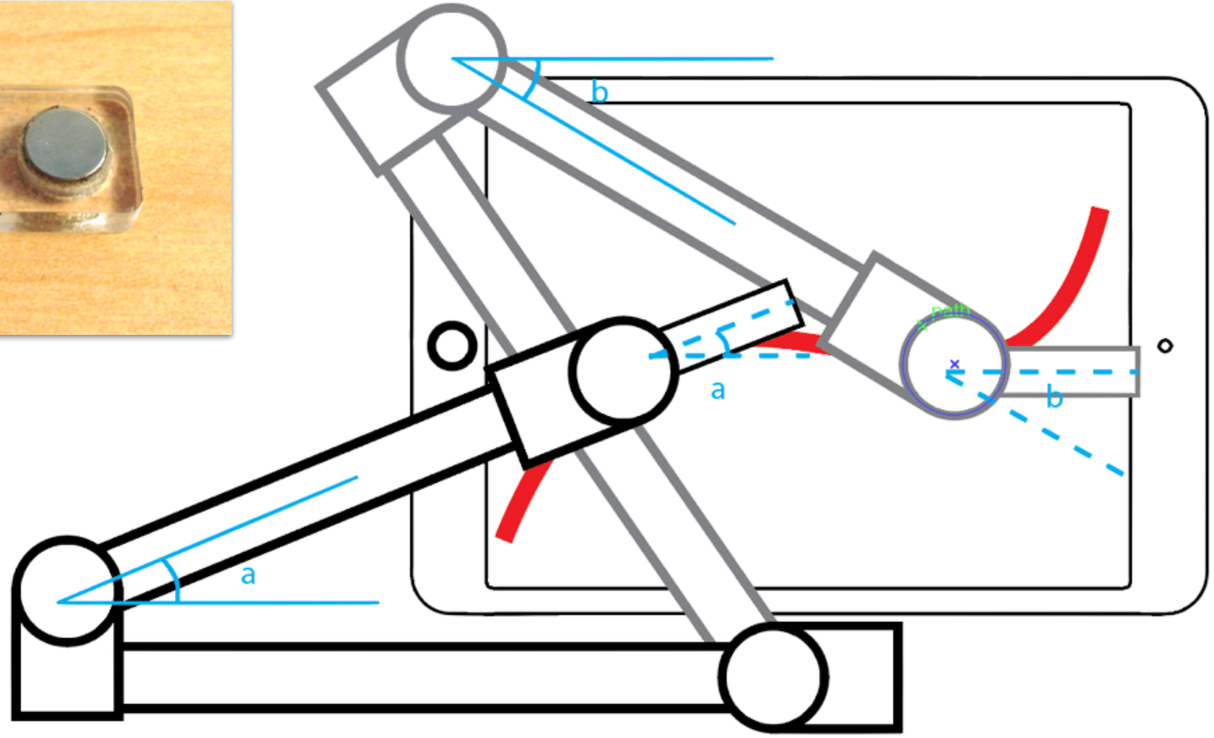
Interaction

Soft constraint

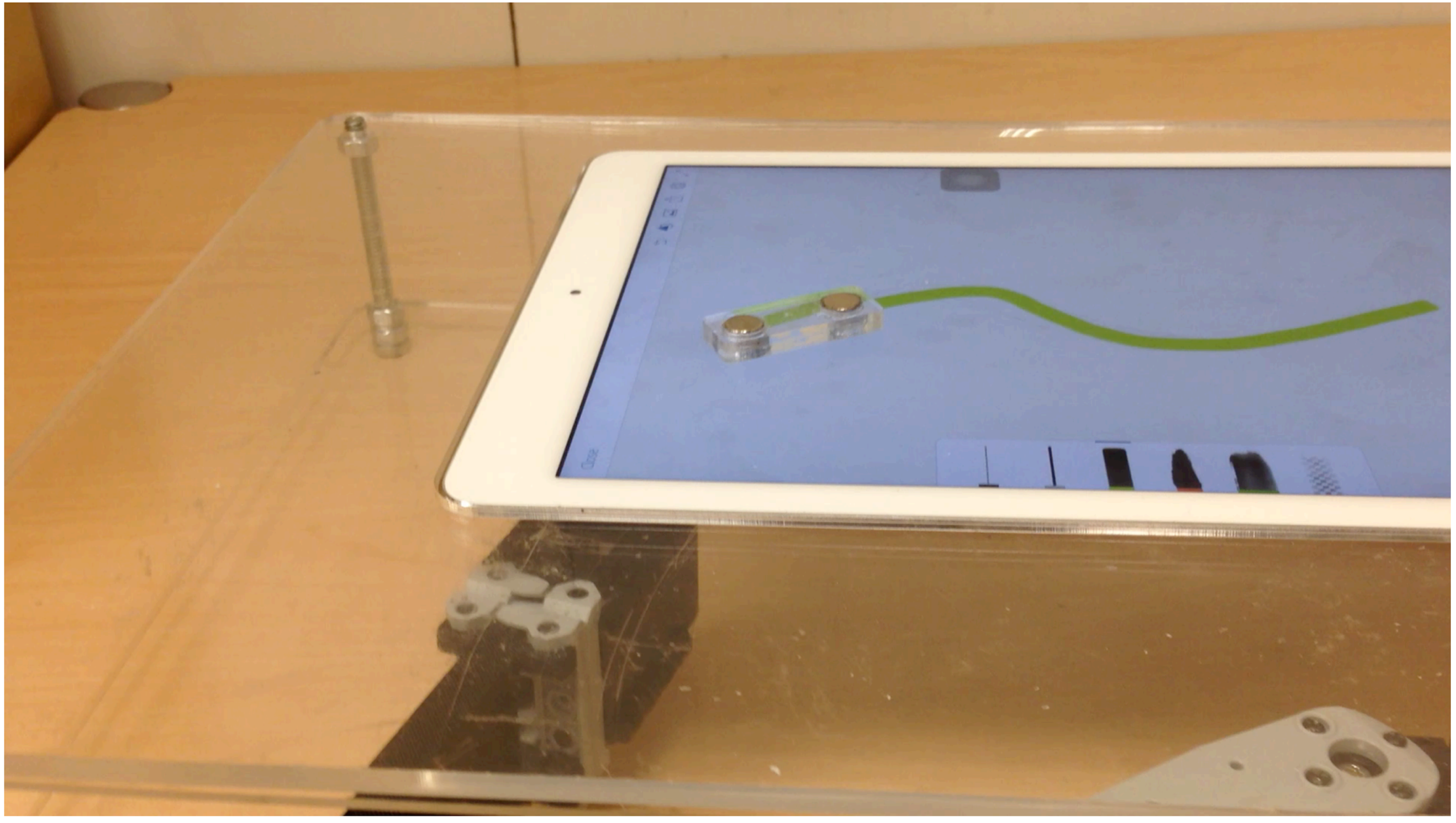


Toward orientation:





Toward orientation:

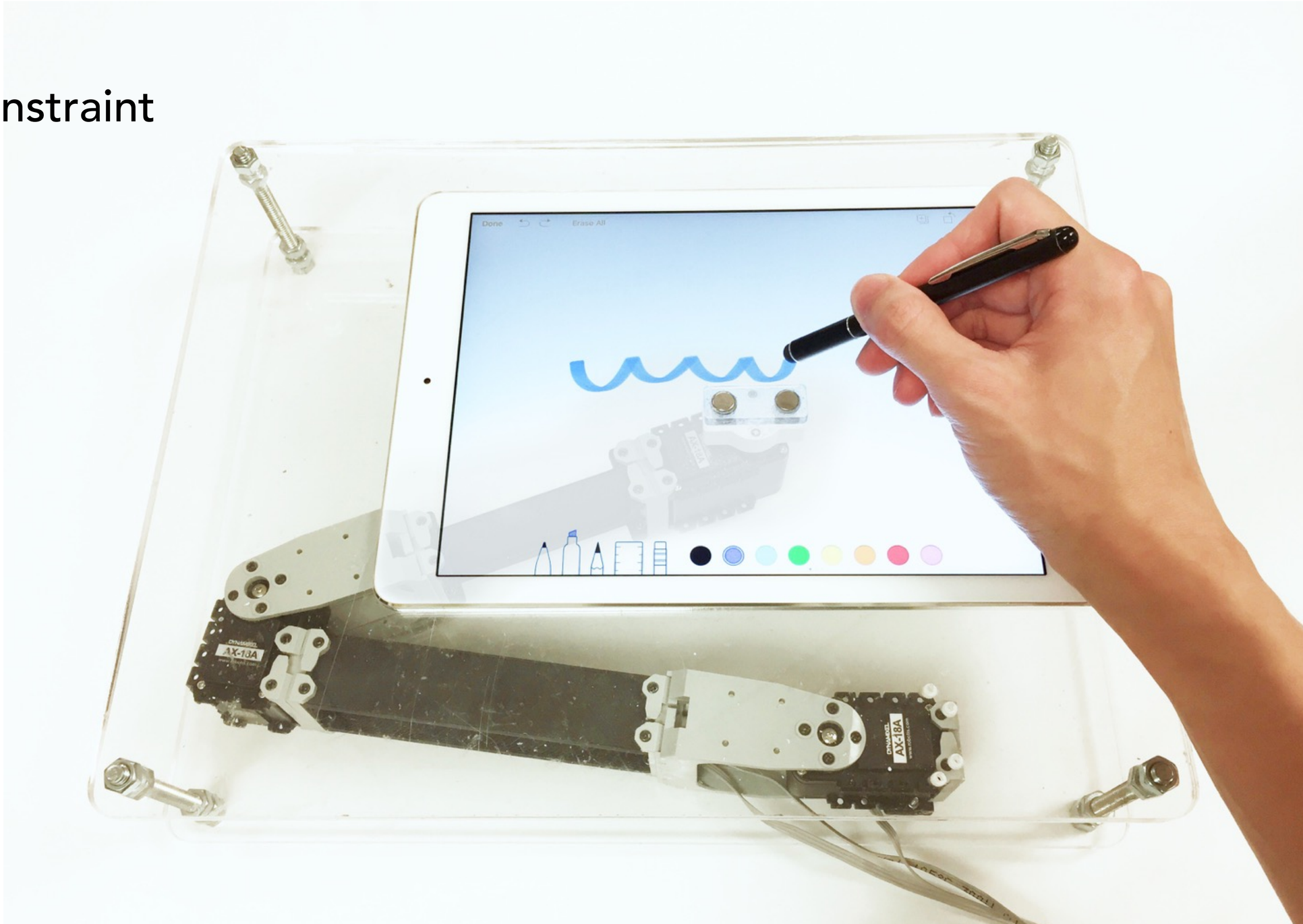


DynaBase

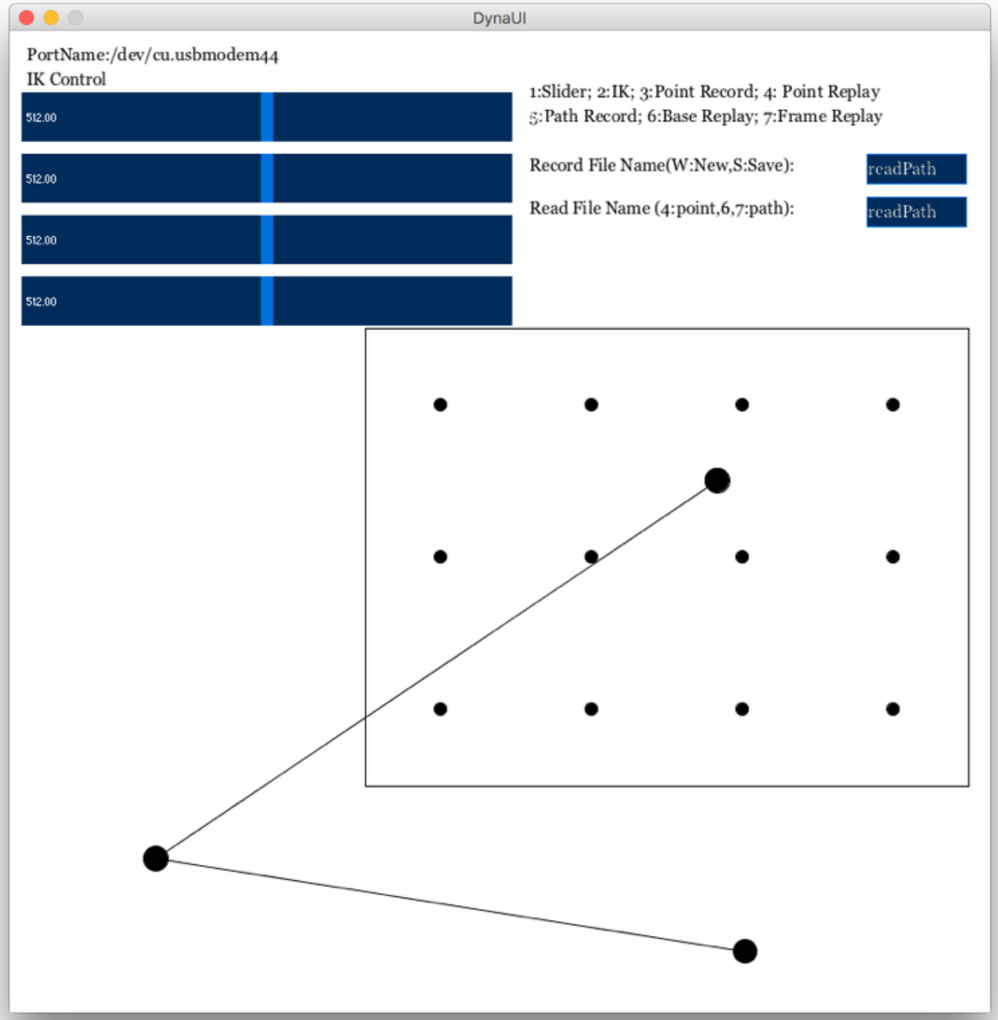
Back-of-display constraint

2D guidance
with orientation

Soft constraint



DynaFrame & DynaBase: User Interface

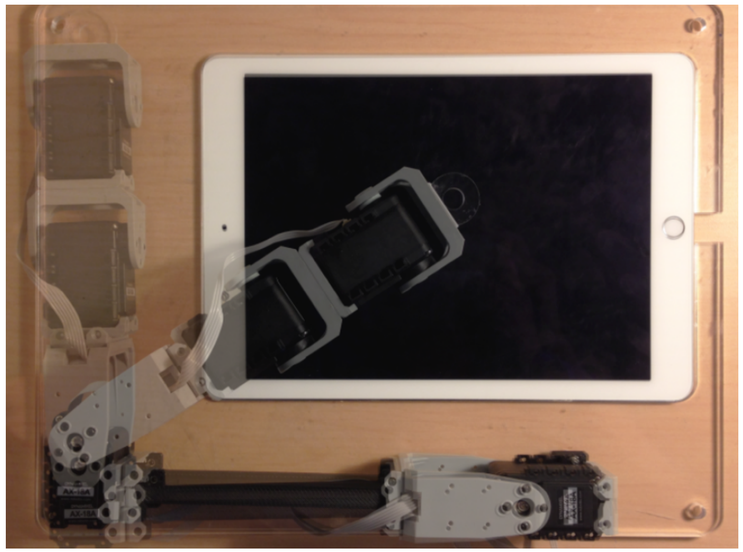


record path & speed playback

robot arm simulation (IK)

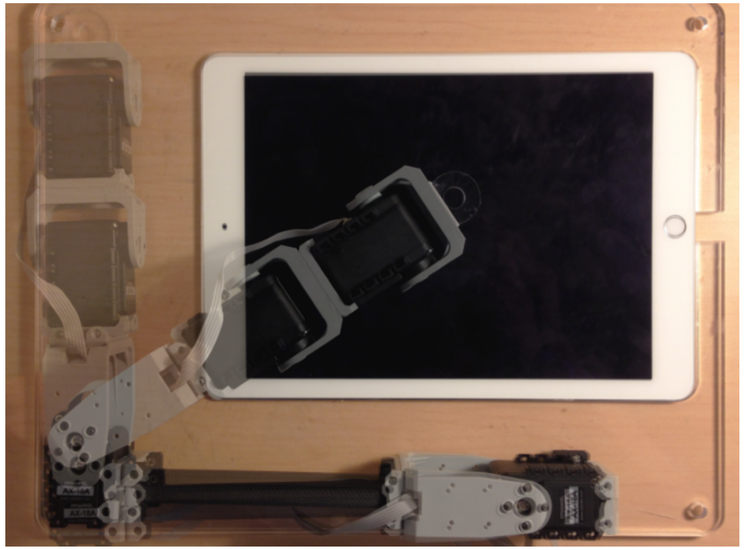
Discussion

Form factor of DynaFrame



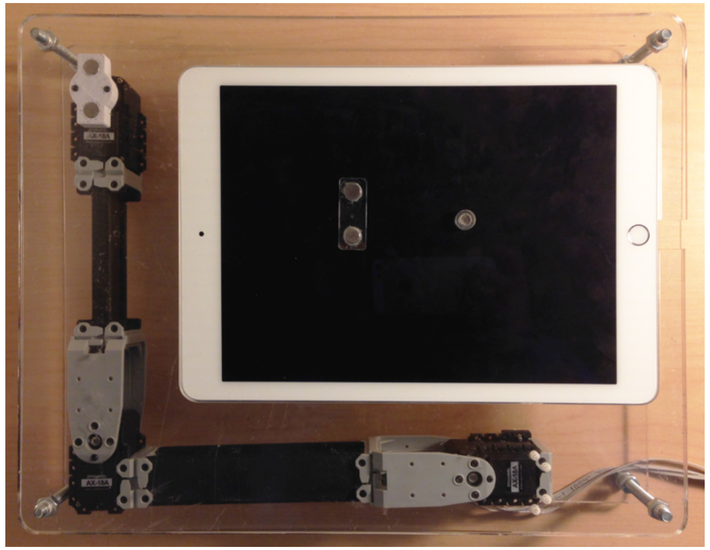
The robot arm provides **good portability** and **adaptability** but needs **control loop**

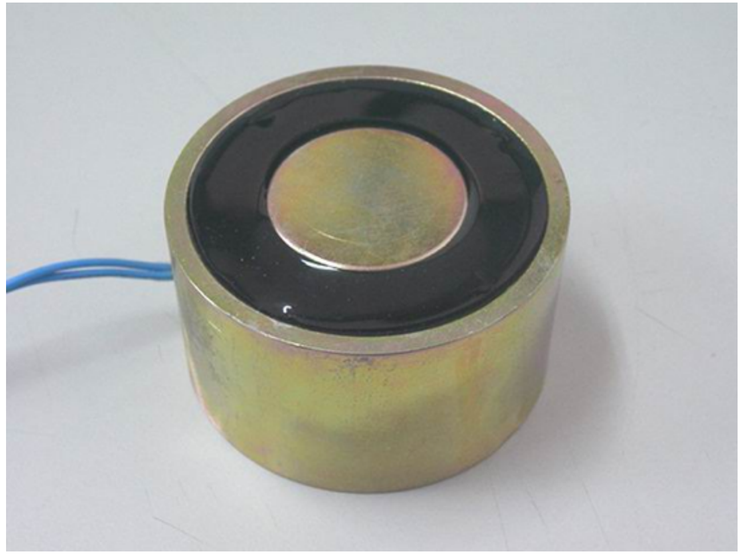
Actuators of DynaFrame



Smaller servos have **less occlusion**
but **small torque** and **low resolution**

Guidance of DynaBase



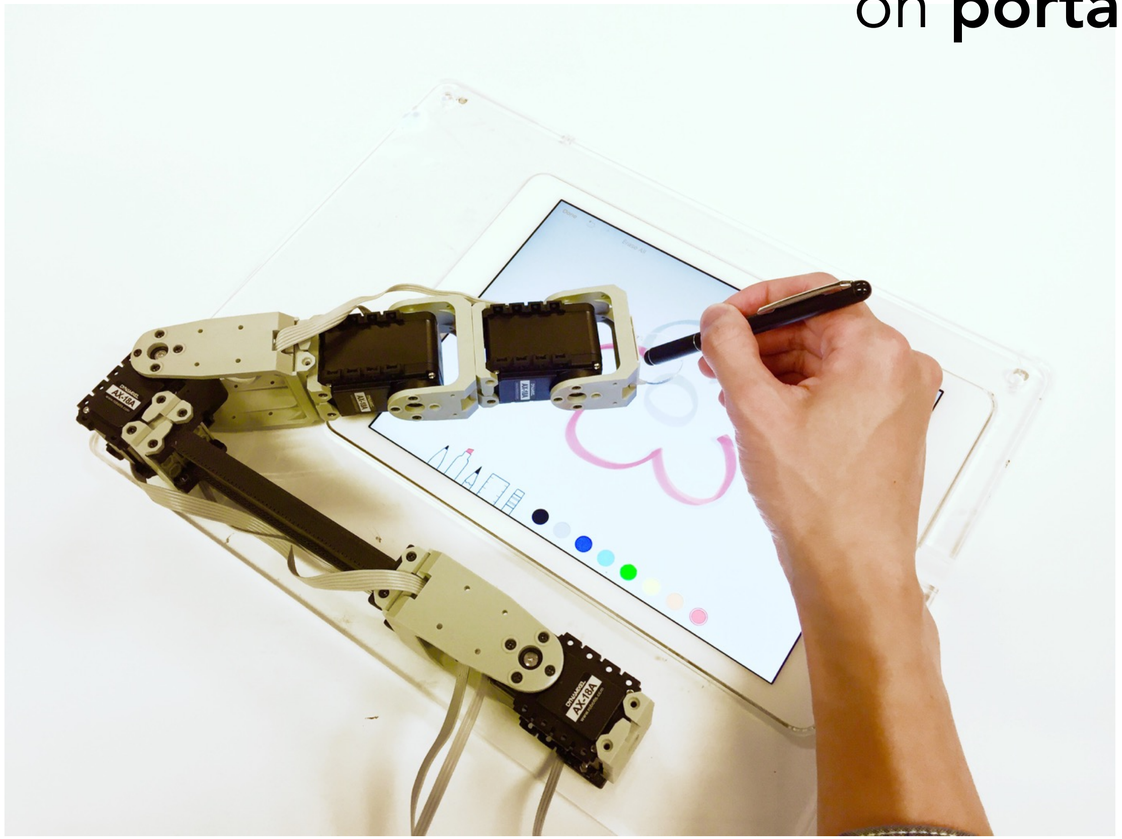


Dynamic attraction adapted to the content
using electromagnets

Conclusion

DynaFrame & DynaBase

hard and **soft** dynamic constraints
to facilitate **stylus** input with rich **haptic** feedback
on **portable displays**



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The End

Emerging Technologies

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