

CREATOR

**FYP**

**Final**

**Presentation**

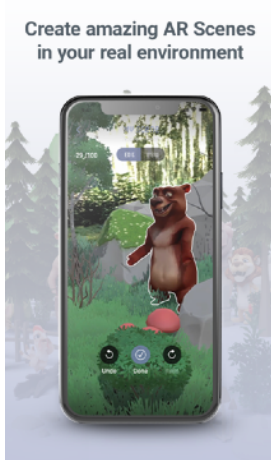
**CREATOR**

**ZHENG Kexin 55198848**

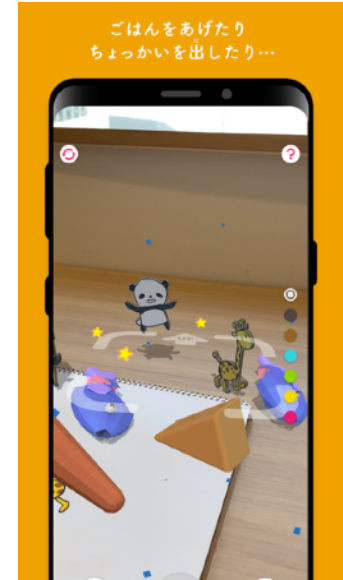
# INTRODUCTION



- 3D augmented reality scenes usually are constructed with **pre-made model generated with computer software**
- Existing application only provides **limited animation effects** which **are not closely related to the real environment**



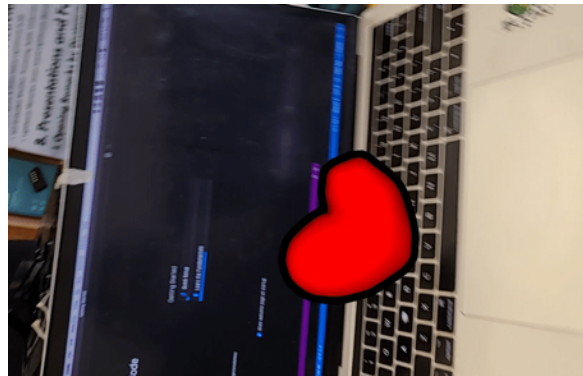
AR.fx  
Artist (2021)



RakugakiAR  
Whatever-Inc. (2020)

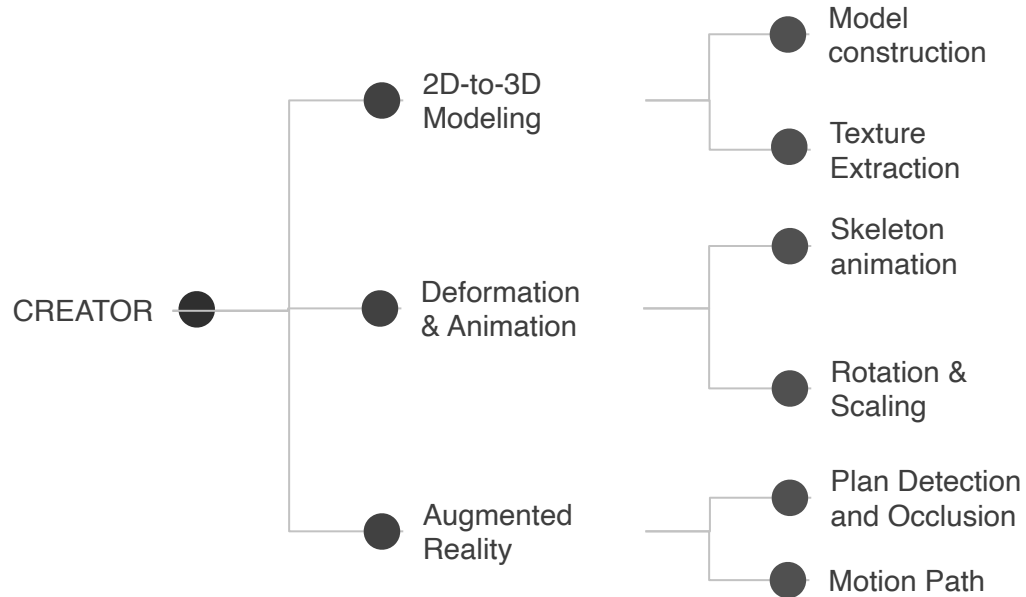


CREATOR is an mobile application that can  
**create 3D animated AR scene**  
using **simple 2D sketches**



# Implementation

# System Structure



# 2D-to-3D Modeling System

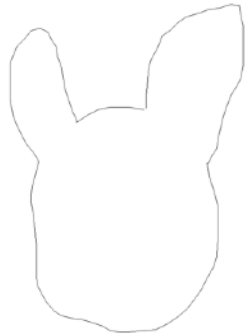
- Contour Extraction
- Delaunay Triangulation
- Mesh Inflation based on distance map
- Texture Mapping
- Laplacian Smoothing



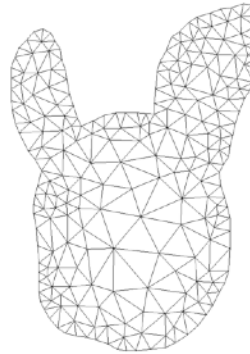
# 2D-to-3D Modeling



Origin Sketch



Extracted  
Contour



Triangulated  
Mesh



Final Textured  
Model

→  
Winding algorithm

→  
Delaunay Triangulation  
\*using package by mattatz

→  
-Mesh Inflation  
-Symmetrization  
-Laplacian smoothing  
-UV calculation

# Deformation & Animation System



## **Skeleton Deformation**

- Sphere Mesh Approximation
- Skeleton construction based on user-input
- Heat equilibrium weight calculation

## **Scale & Rotate Deformation**

- Pinch - Scale
- Slide - Rotate

## **Keyframe Animation**

- 24 frames per-second
- 6 Key position

# Model deformation on Computer

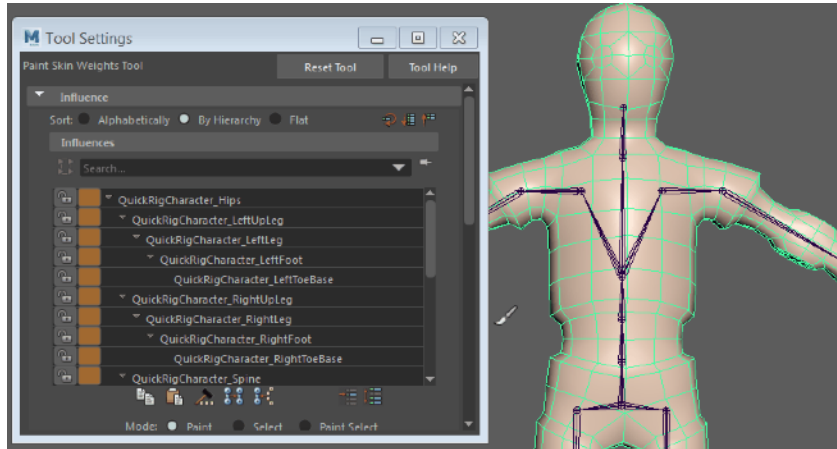
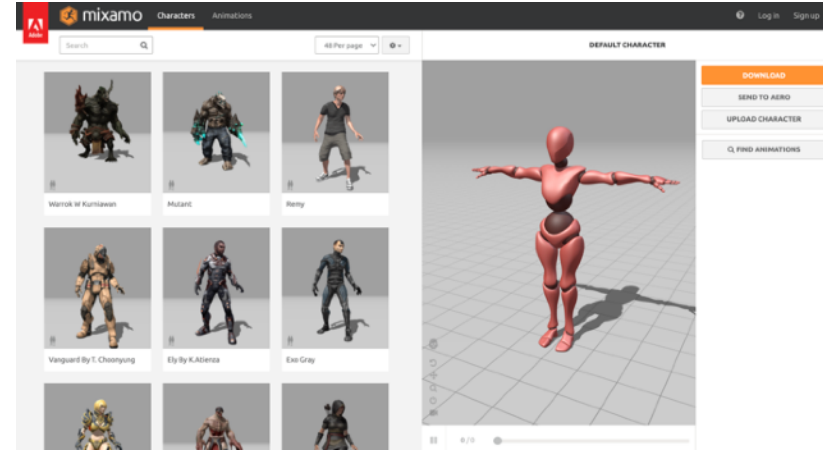


Image credit: Autodesk.Help

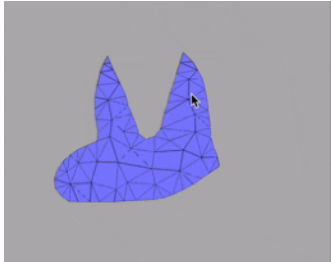


Screenshot of Mixamo (Adobe, 2021)

# Model deformation on mobile?

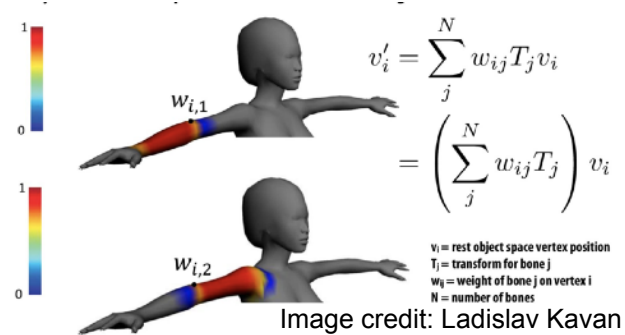
- Fast computation for real-time performance.
- No complex rigging process
- Easy to manipulate

- Direct Manipulation



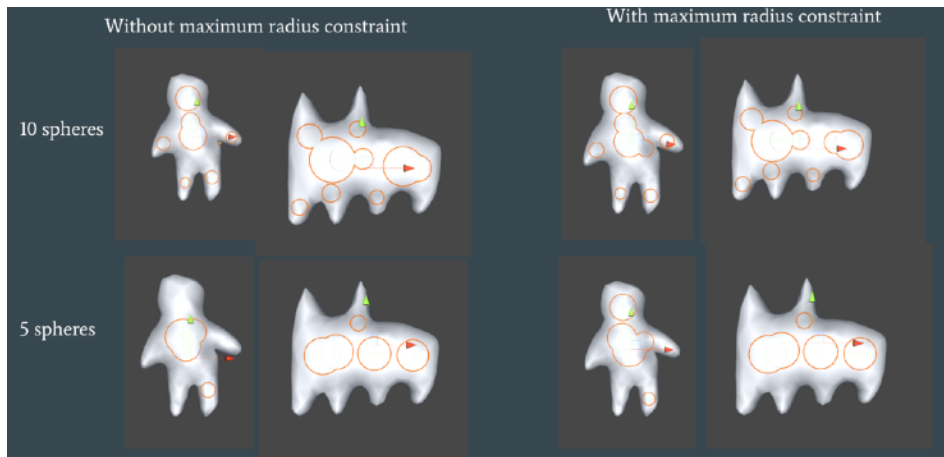
As-rigid-as possible shape manipulation  
(Igarashi et.al,2005)

- Skeleton-based deformation



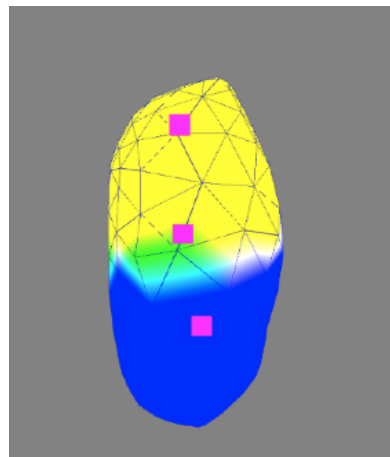
Linear Blend Skinning (Magenat-thalmann, 1988)

# Auto-rigging method for mobile



## Joint Position

Sphere Mesh Approximation (Thiery, 2016) on sketch models



## Joint Weight

Heat-equilibrium Weight  
(Baran & Popovic, 2007)  
on sketch model

# Auto-rigging Method

One root bones





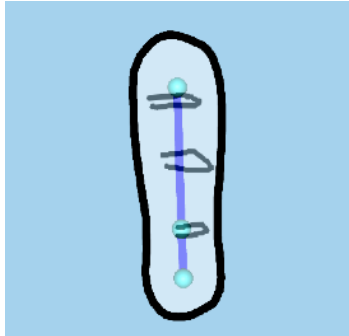
# Auto-rigging Results

Number of Bones:

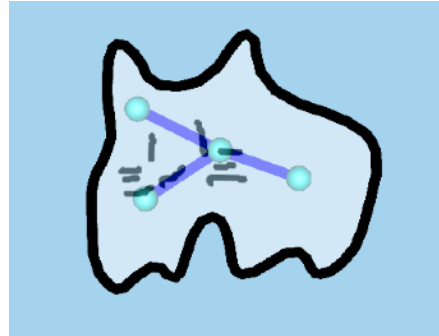
5



Generate Bone



3 bones



4 bones



5 bones



6 bones

# Skeleton Deformation

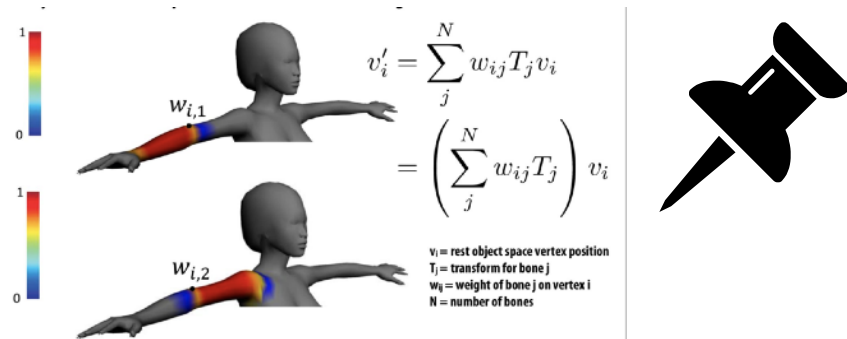


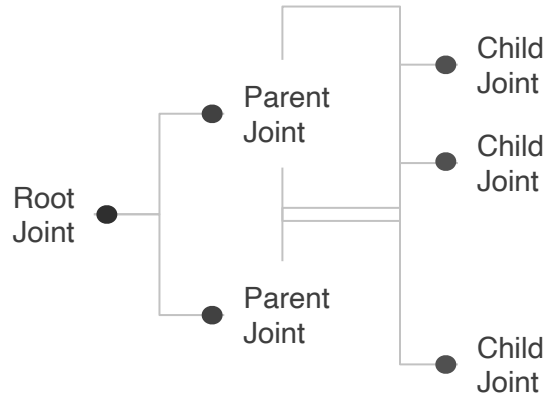
Image credit: Ladislav Kavan



Origin



Deformed



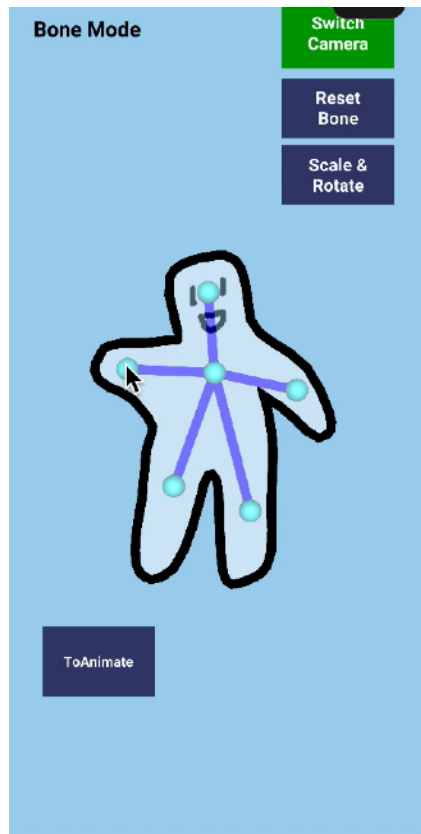
# Linear Blend Skinning

(Magenat-thalmann, 1988)

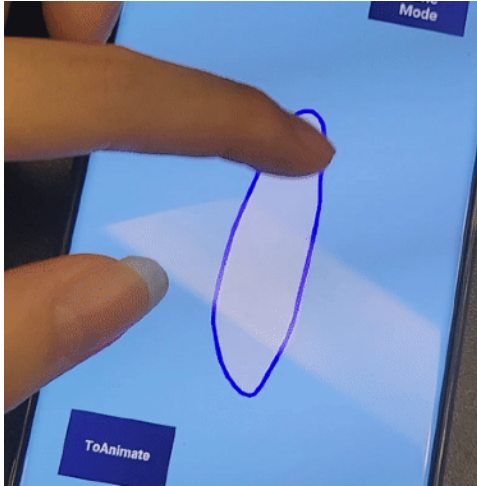
## Deform a vertex:

- A: Parent joint transformation matrix relative to model center
- B: Joint transformation matrix relative to parent
- C: Joint Initial position matrix relative to parent
- D: Vertex position matrix relative to joint
- E: Vertex position matrix relative to model center

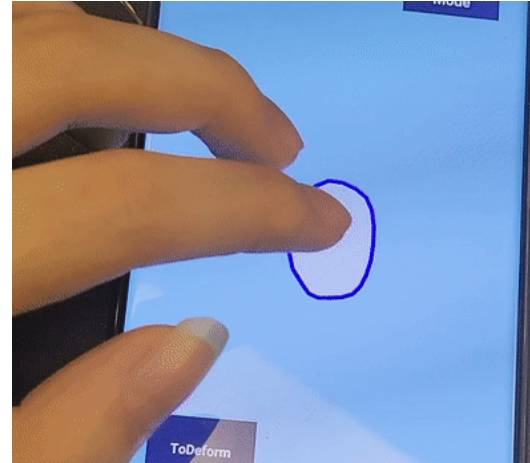
**Final transformation matrix =  $A * B * C * D * \text{inverse}(E)$**



# Scale & Rotate



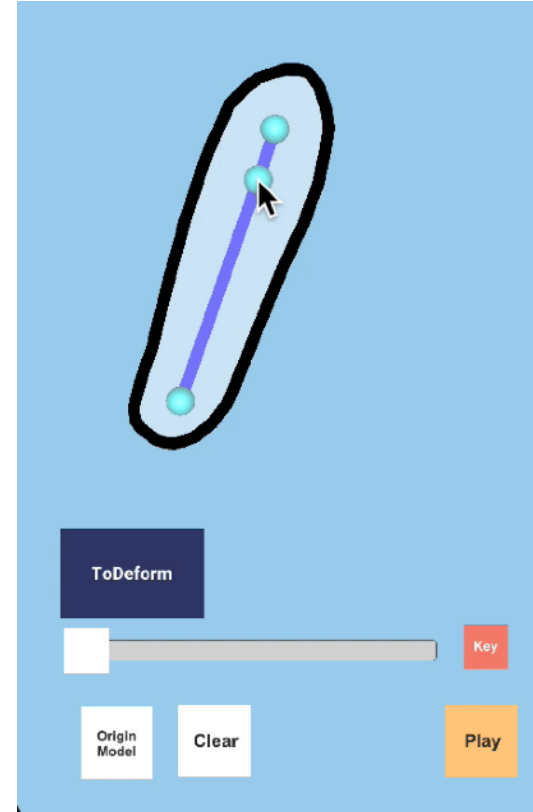
Rotate – Slide



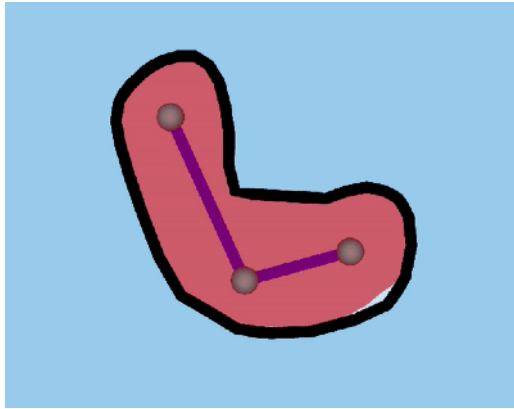
Scale - Pinch

# Keyframe Animation

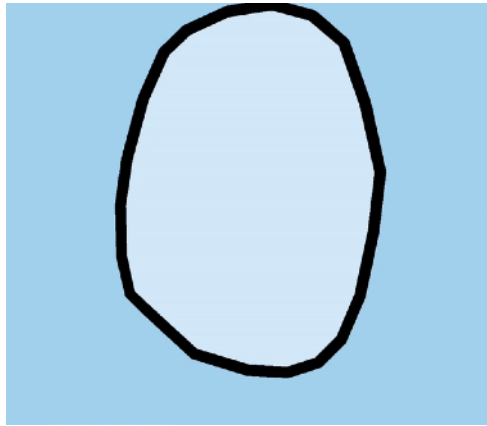
- 24 frames per second
- Record the **position and rotation of each joint** or the **rotation and scale of the whole model** when keyed
- **Automatically calculate the interpolation** between keys using sphere linear interpolation



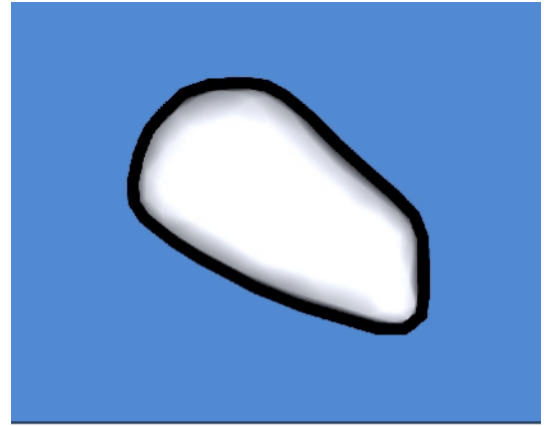
# Keyframe Animation



Bone Animation



Rotation and Scaling



Combined animation



# Augmented Reality

## Motion Path

- AR Anchor based
- Mid-point Smoothing on 3D curve
- Moving speed change based on user input

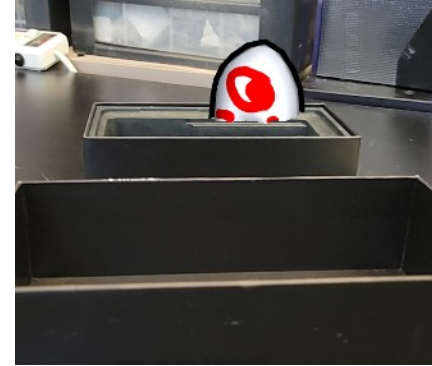
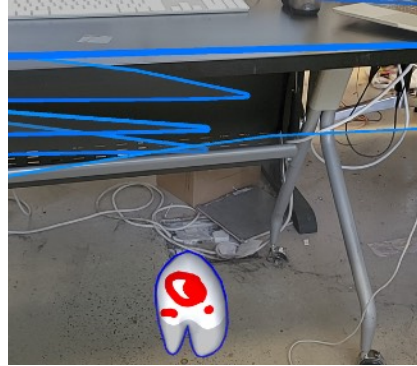
## AR Environment

- AR Plane for object placement
- AR Occlusion
- AR Anchor for position tracking



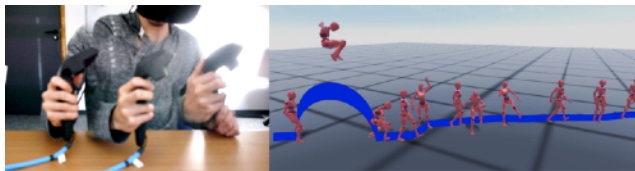
# AR Environment

- Plane Detection
- Occlusion



# Motion Path

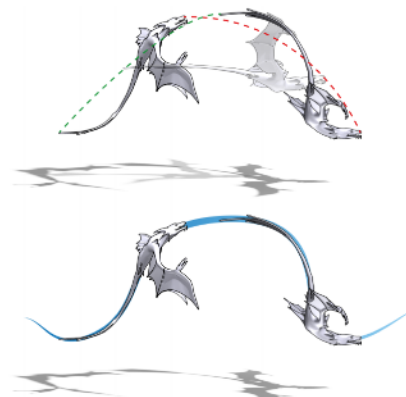
Easy Intuitive ways to create animation



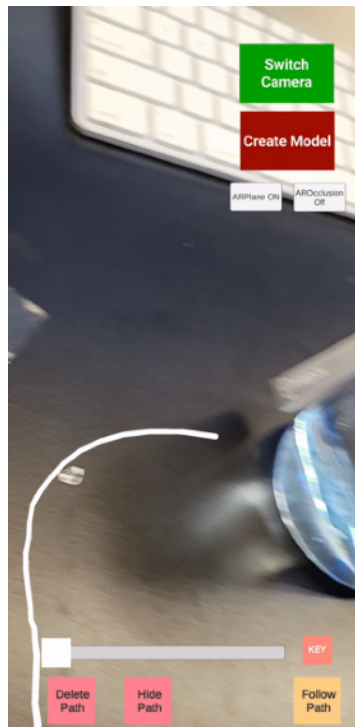
Spatial Motion Doodles ( Garcia et al. 2019)

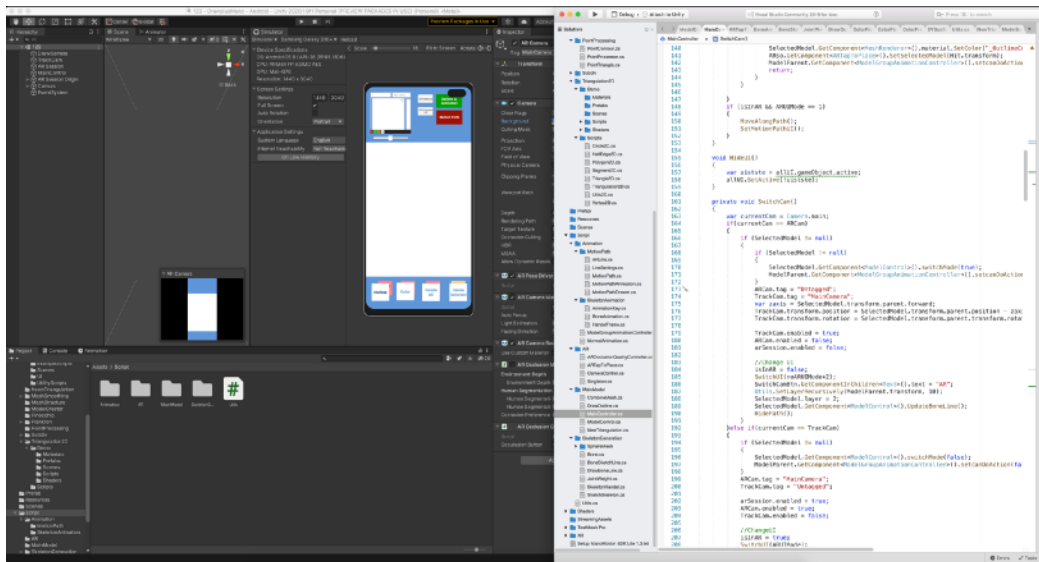


AR Animator(Ye et,al, 2020)



Space-time sketching (Guay et.al, 2015)

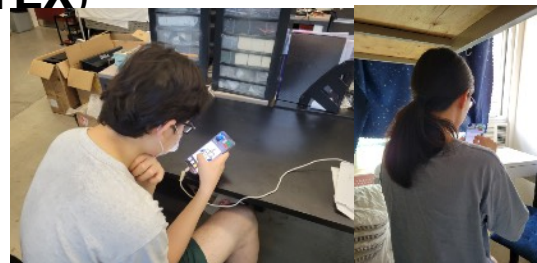




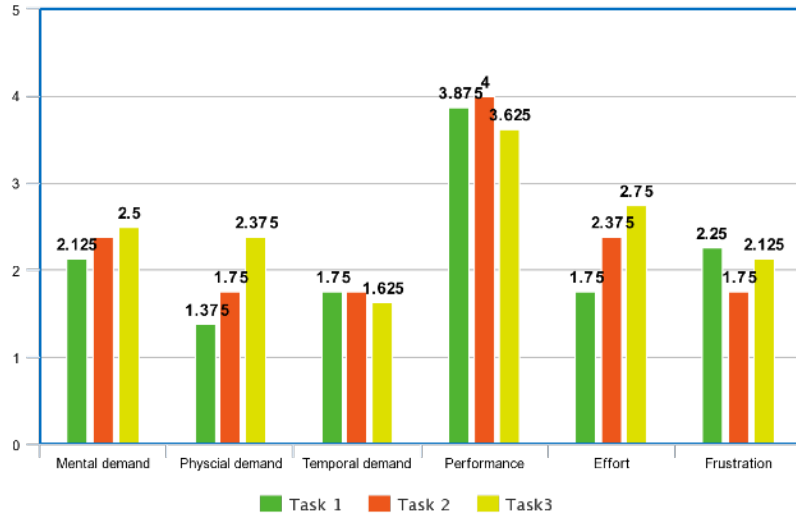
# Usability Study



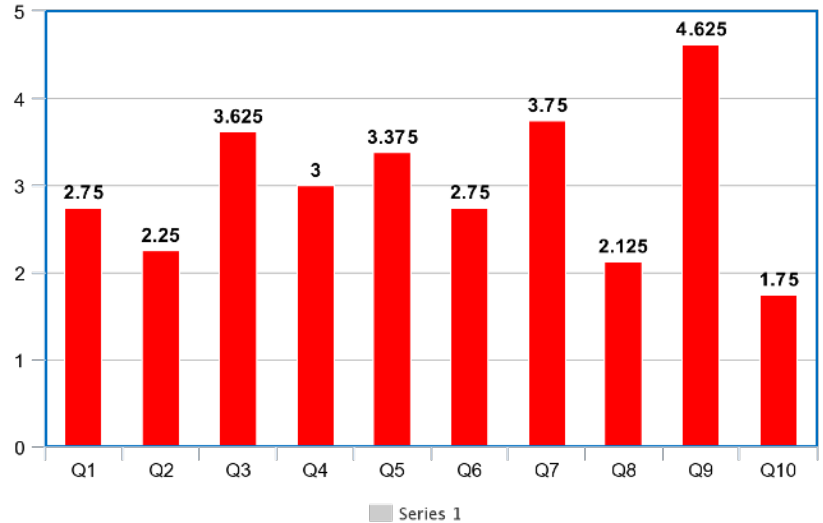
- **8 Participants.** 3 Male 5 Female. Age from 21 to 30.
- **3 Tasks**
  - T1: use CREATOR to **model and deform** 3 models
  - T2: use CREATOR to create keyframe **animations** for 3 models
  - T3: use CREATOR to create an **AR scene** that combining all the functions provided by the system.
- **2 Evaluation form:**
  - NASA Task Load Index (**NASA-TLX**)
  - System Usability Scale (**SUS**)



# Results



NASA-TLX



SUS

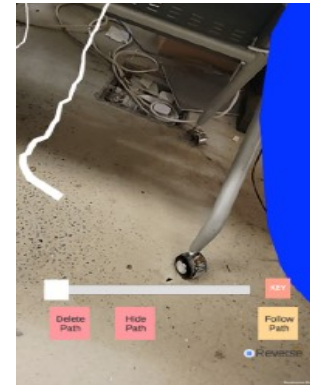
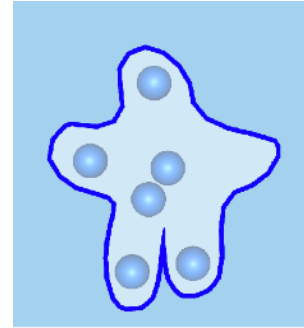
# Discussion

# Limitation-Usability

- UI design
- 3D modeling style
- Switch between different systems is a bit complex
- Should provide in-app instruction for first-time user
- Skeleton joint movement is only in 2D.
- Auto-rigging function's joint position cannot be edited

# Limitation-Technical

- Contour detection error on complex shape
- Slow weight calculation time
- Deformation artefact
- Weight Calculation error
- Camera tracking loss in AR



# Future Development

- Improve contour detection method
- Refine auto-rigging method. Possibly adding editing function.
- Better matrix computing method for weight calculation
- Better 3D curve smoothing method
  
- Define target user group clearly for better function integration
- Improve UI design and structure

# **Thank You !**