From Design:
Full Procedural Animations for Mechs

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Tomohiro Mori
AI Engineer : SquareEnix

Tomohiro Mori researched about CharacterAI and Animation in Future University Hakodate. He joined SquareEnix in 2019.

He is researching AI and Animation
-Full Procedural Animation
-Character AI using Hierarchical Task Network

Kousuke Namiki
Senior AI Engineer : SquareEnix

Kousuke Namiki has been involved in the game industry since 2008, and joined SquareEnix in 2012.

He worked in the development of titles such as
 - FINAL FANTASY XV
 - KINGDOM HEARTS III
 - FINAL FANTASY VII REMAKE
as Game AI engineer and QA automation AI engineer.

Currently, he is engaged in research and development of next-generation AI system in Advanced Technology Division.

Introduction

Our Purpose

- Animation System for Fully Customizable Mechs
  - Many Possible Combinations
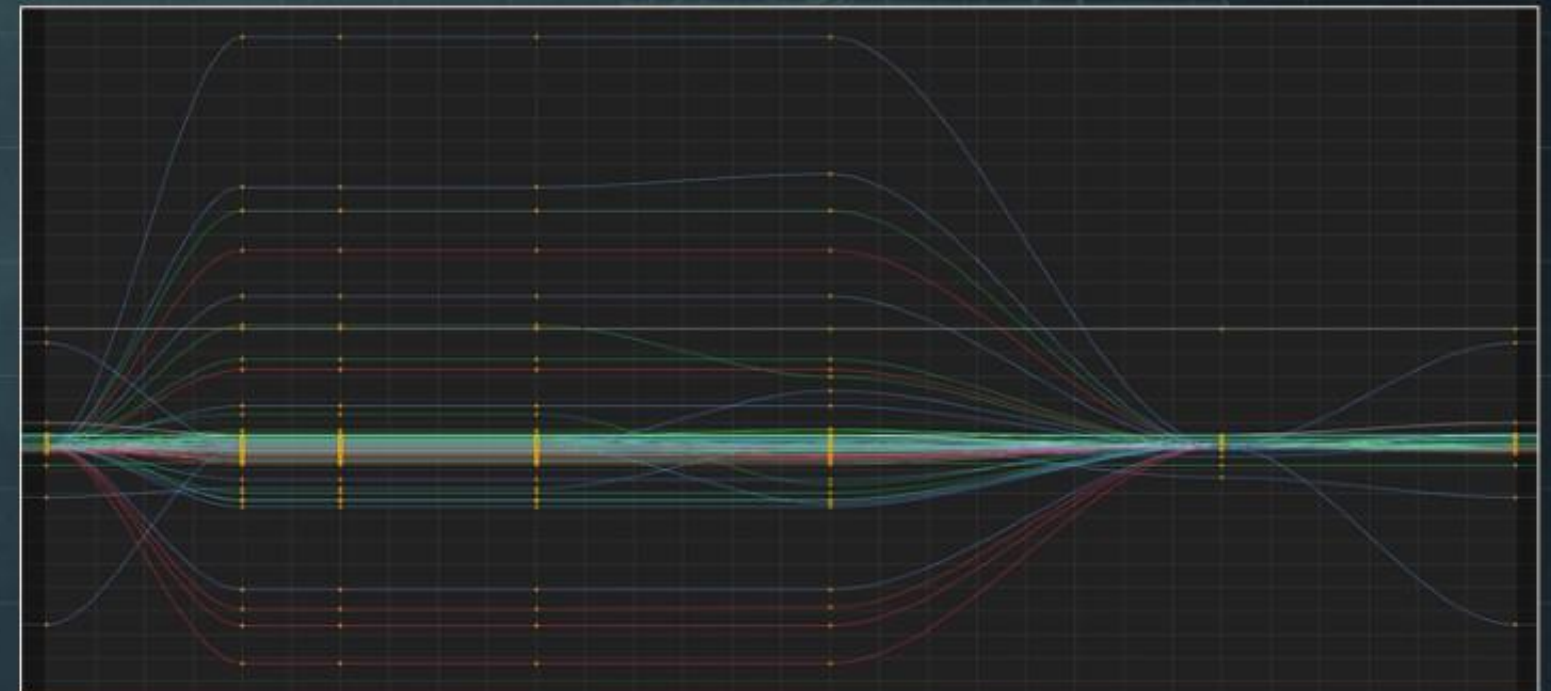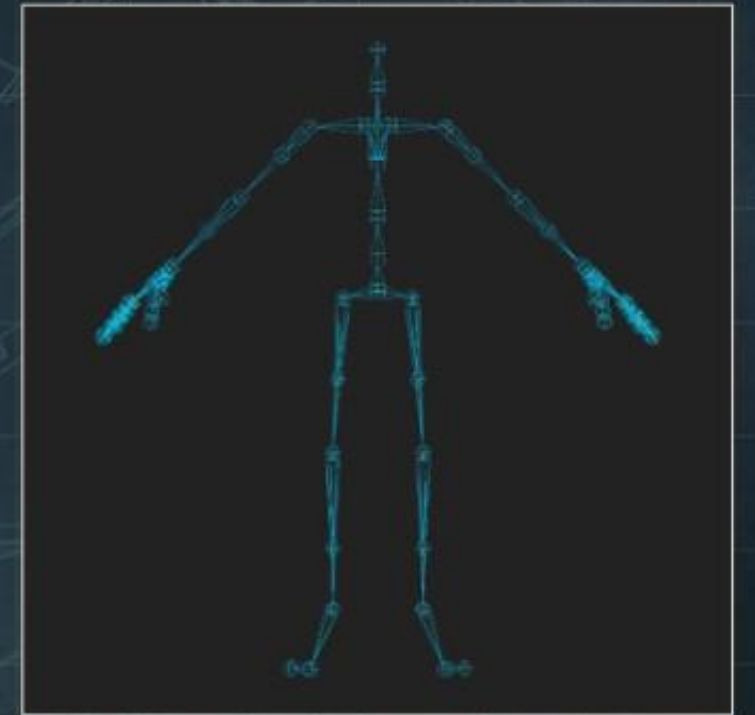 - Combinations May Have Different Joint Structures

Back Ground

- Traditionally in Mech games, Mech parts were designed within the constraints of joint structure

Traditional Animation System

- Models are animated by Animation Asset

- Difficult to attach many models

  - Difference of Joint Structures

  - Difference Collision

  - Difference Environment

Traditional Procedural Animation

- Traditional Procedural Animation edits Animation Asset according to the environments

- The Procedural Animation need Animation Asset
  - Can't solve Difference of Joint Structures
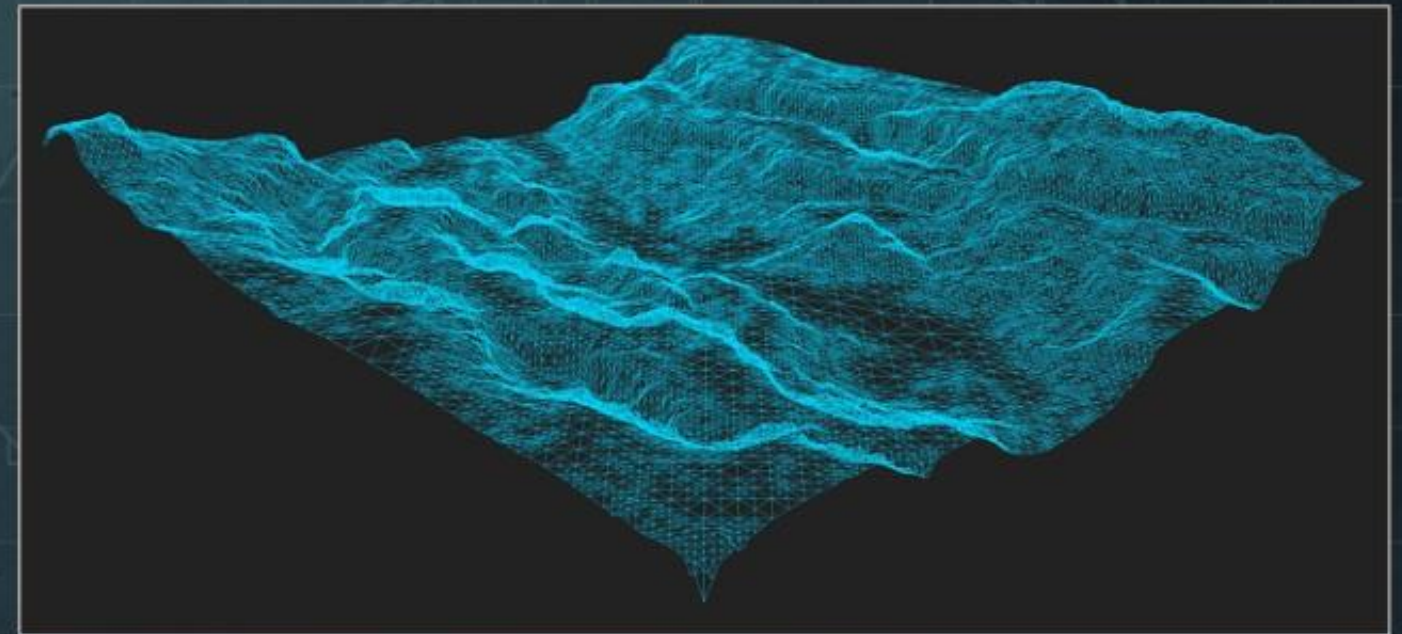
"*Animation Follows Form*"

"Form Follows Function" by Louis Sullivan

Real-Time Full Procedural Animation

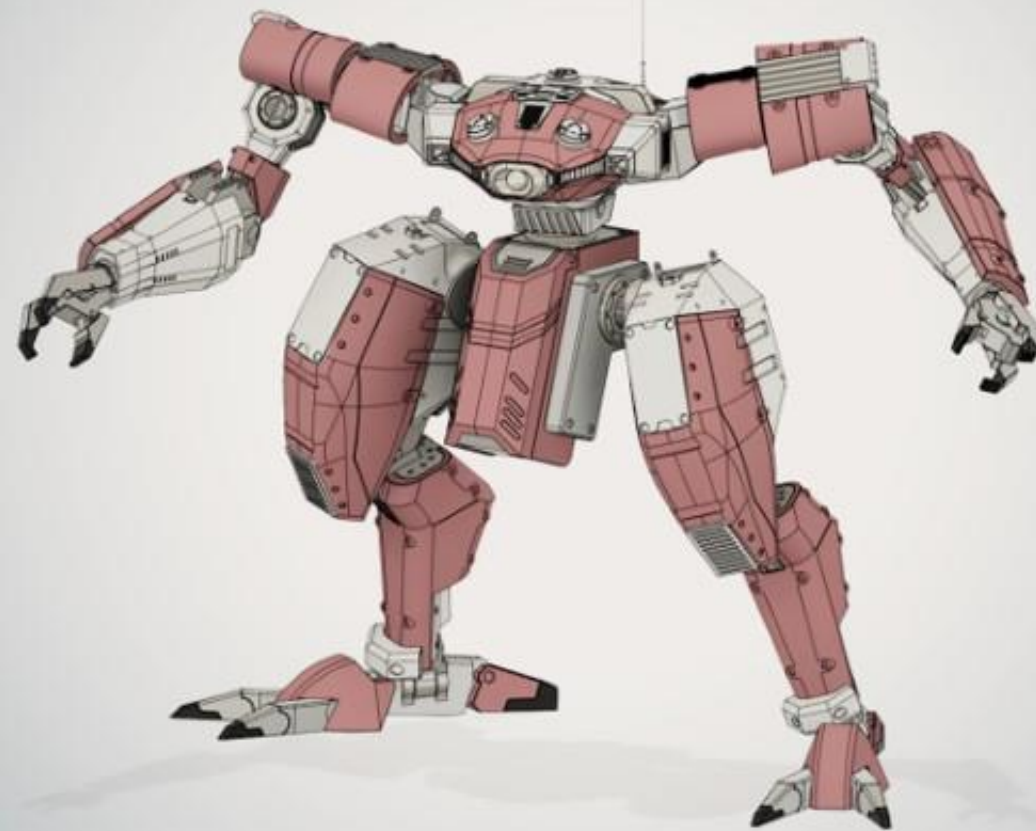MULS (Multi Unit Link System)

MULS (Multi Unit Link System)

- No Animation Asset

- Attach to various robot models
  - Able to use various Parts

- Correspond to various terrain
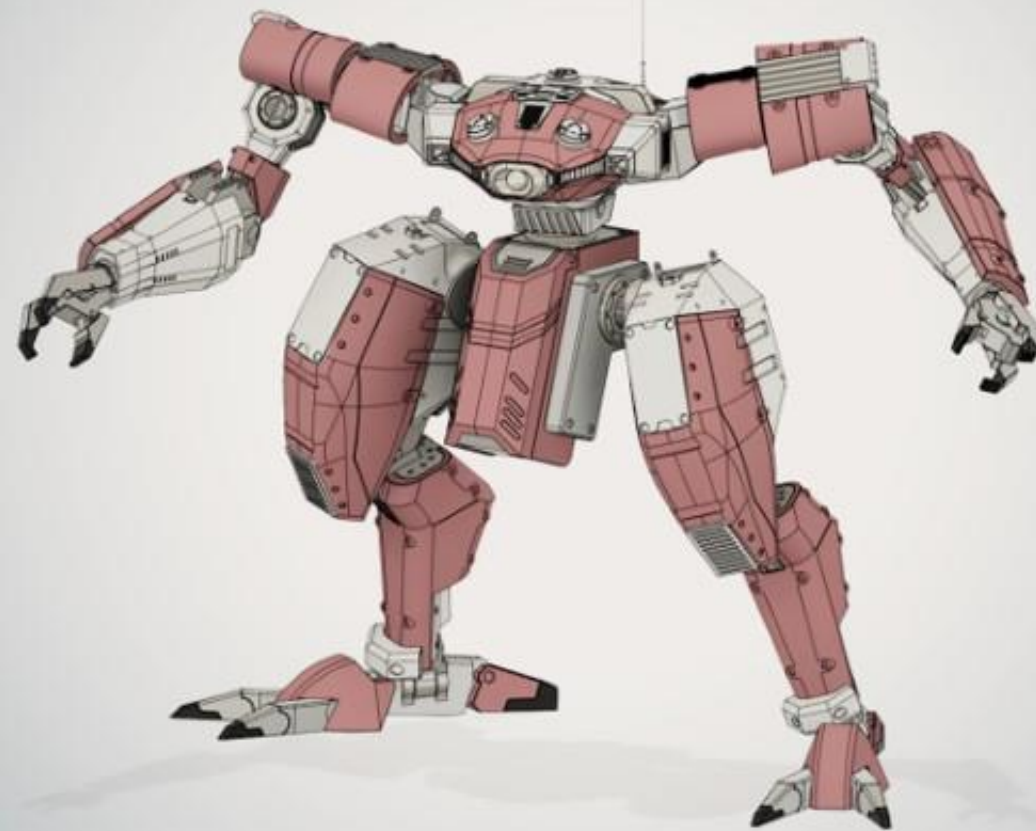
Animation is made by model's form

MULS (Multi Unit Link System)

- Our system requires
  - No Bone
  - No Skinning
  - No Rigging
  - No Animation

MULS (Multi Unit Link System)

- Our system requires
  - ~~No Bone~~
  - ~~No Skinning~~
  - No Rigging
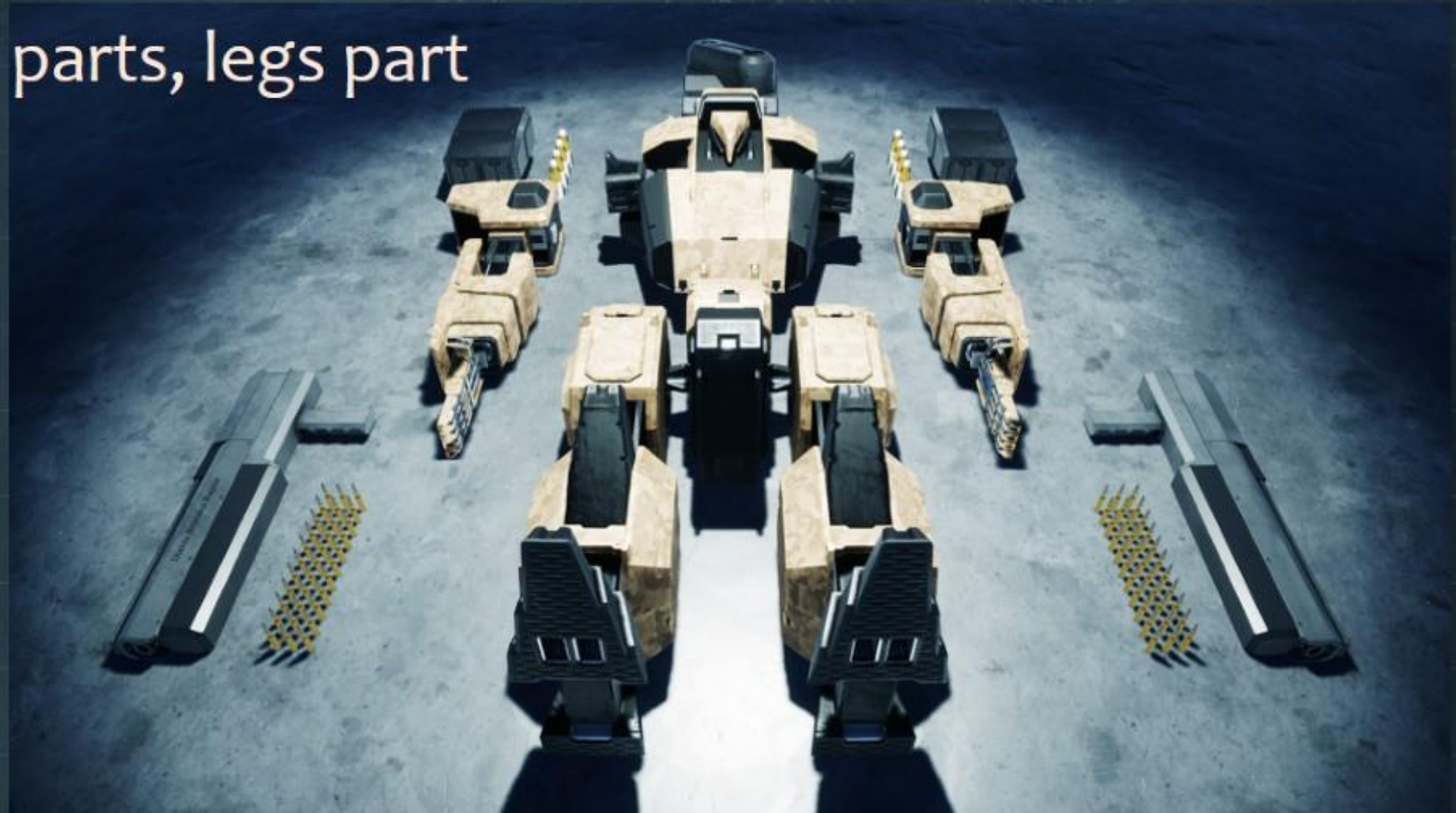 - No Animation

MULS's Animation

- **Walk**
- **Aim**
- Search
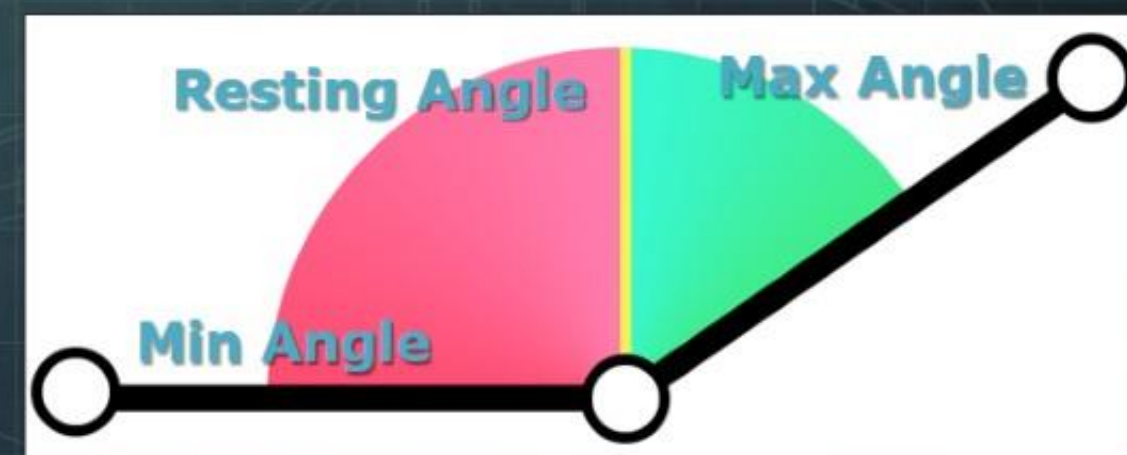- Look At
- Look Around
- Idle
- etc.

Mech Model

Information of Robot model

- Robots have 2 legs, 2 arms, and Body

- Made by body part, 2 arm parts, legs part

- 1 Joint 1 Axis

- Max and Min Angles

Joints Status

- Joint Indicator GUI
  - Joint Network Graph
  - Show movement of joint
  - Show Blocking Joint by angle limit
  - Current Angle
  - Rotation Axis

Animation Data

- Animation Data ≠ Animation Asset
- Animation Data means parameters
  - Step Length in Walk
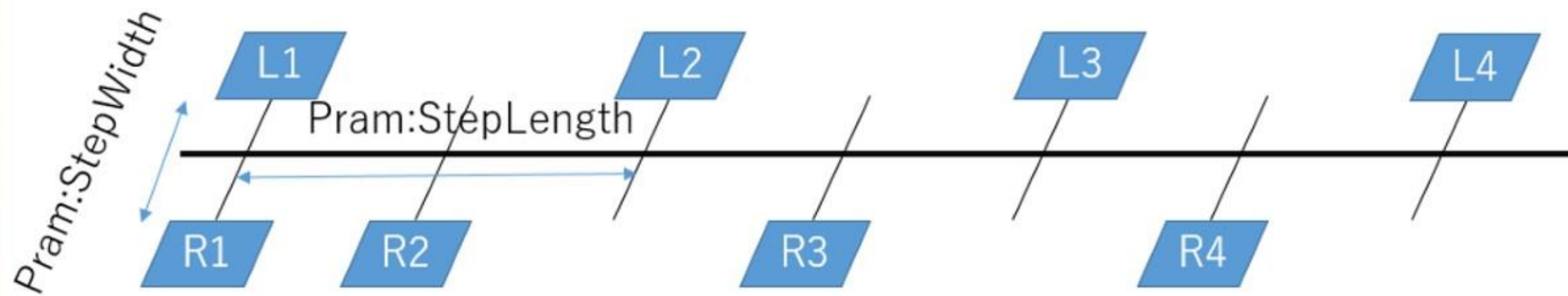 - Animation Time in Aim
  - Rotate Angle in Search
  - etc.

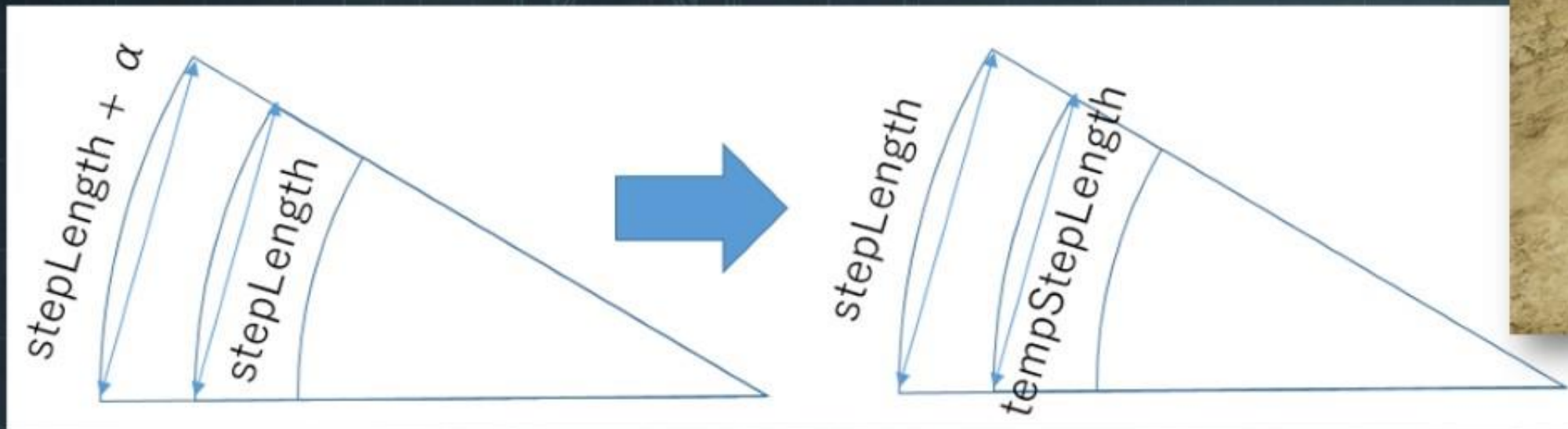Walk Animation

Walk Animation

Footstep Generation:

- Advance the location by half of the StepLength

- Offset by half of the StepWidth

- Place Footstep

Walk Animation

- In curve course, FootStepMaker put the FootStep so that the length outside the curve is StepLength.

  - To prevent the movement of the outside leg becoming too long

Walk Animation

- The character's feet are aligned with the target calculated from FootStep by CCDIK.

- The waist position is in the middle of foot targets.

- The waist height from the ground is determined by parameters

Param:
Lowest Waist Heigth ~ Highest Waist Height

L1 L2 L3 L4

R1 R3 R4
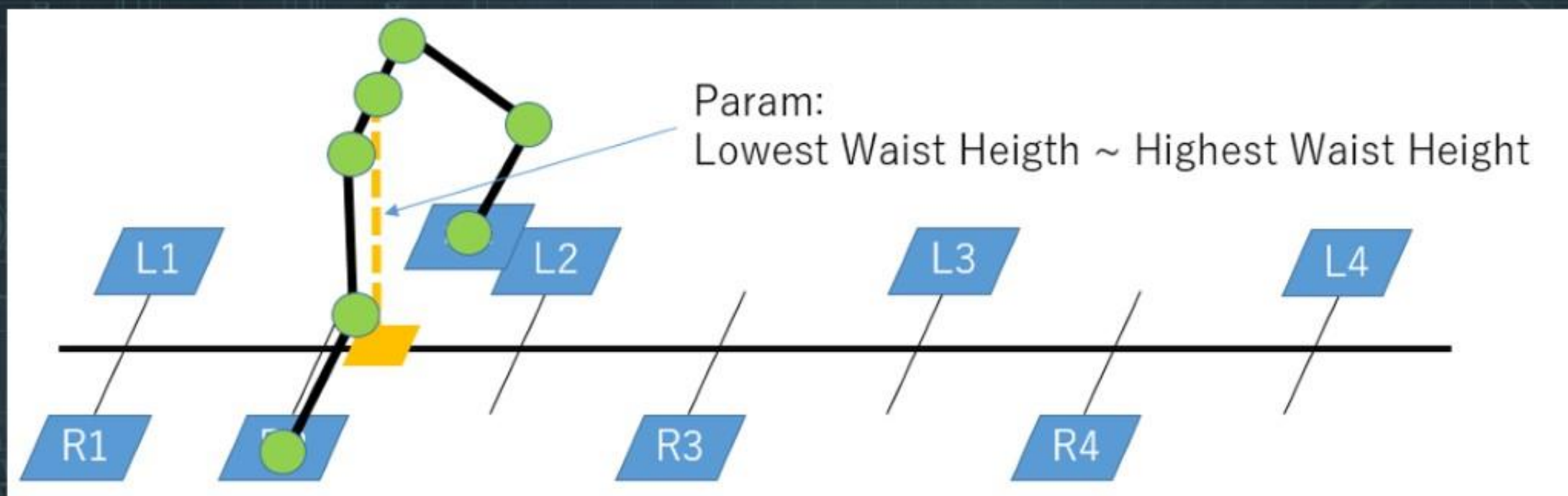
Walk Animation

- The target on landing foot side is the same position as FootStep
- The target on floating foot side moves in elliptical orbit
  - The elliptical orbit is made by [StepLength] and [Toe Clearance]
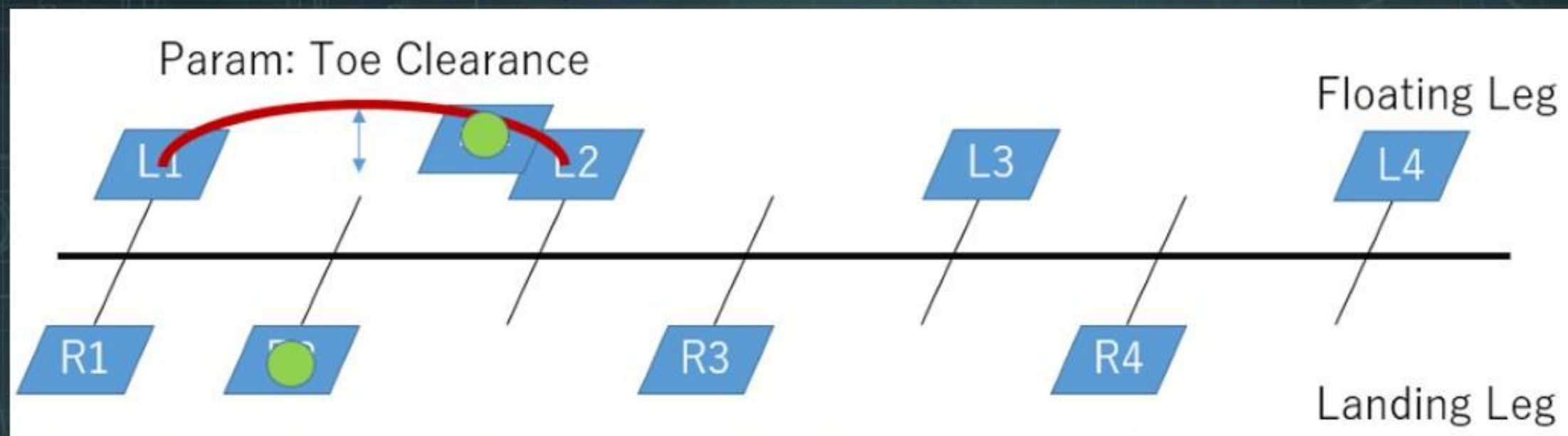
Walk Animation

- FootStep floats from the ground .

- WalkController aligns FootSteps and ankles.

- WalkController rotates ankle joints to match the slope.
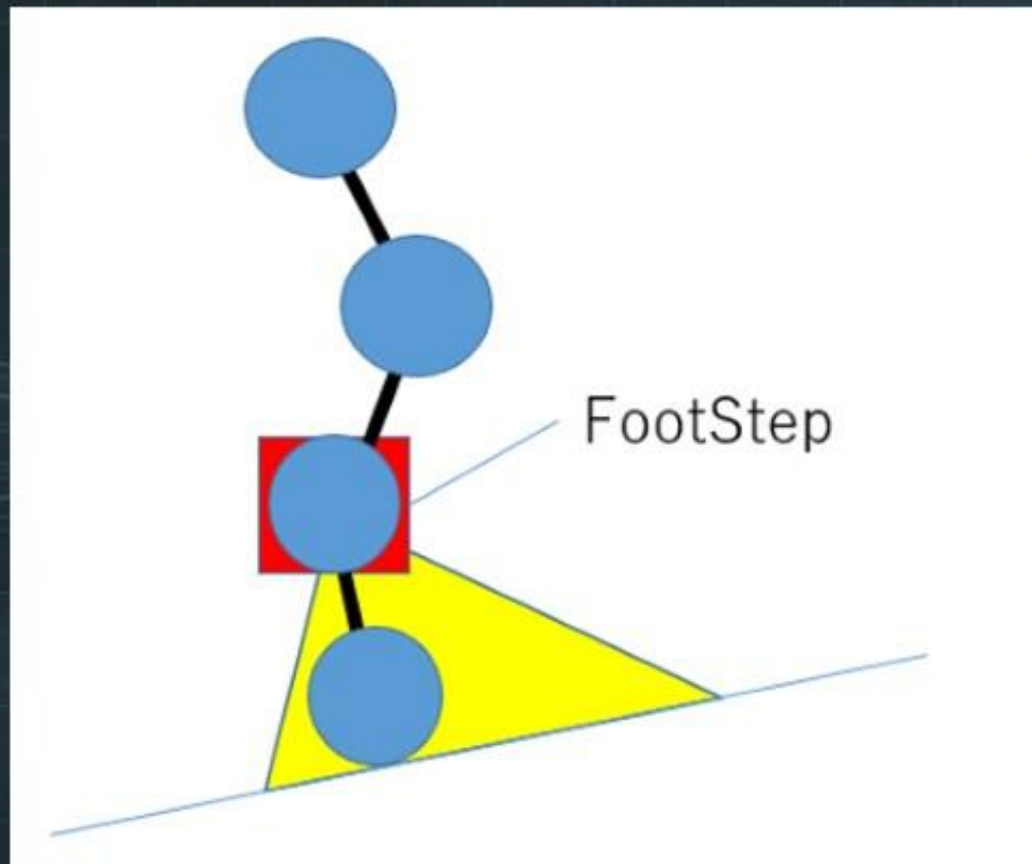
Walk Animation

- Various Foot Meshes
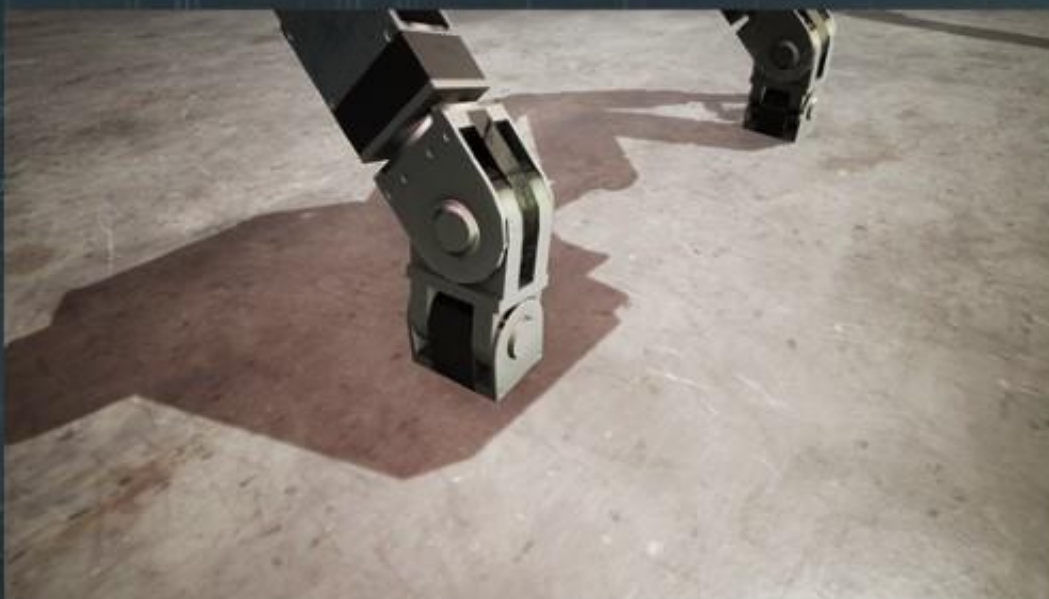
Walk Animation

- Various Foot Joints
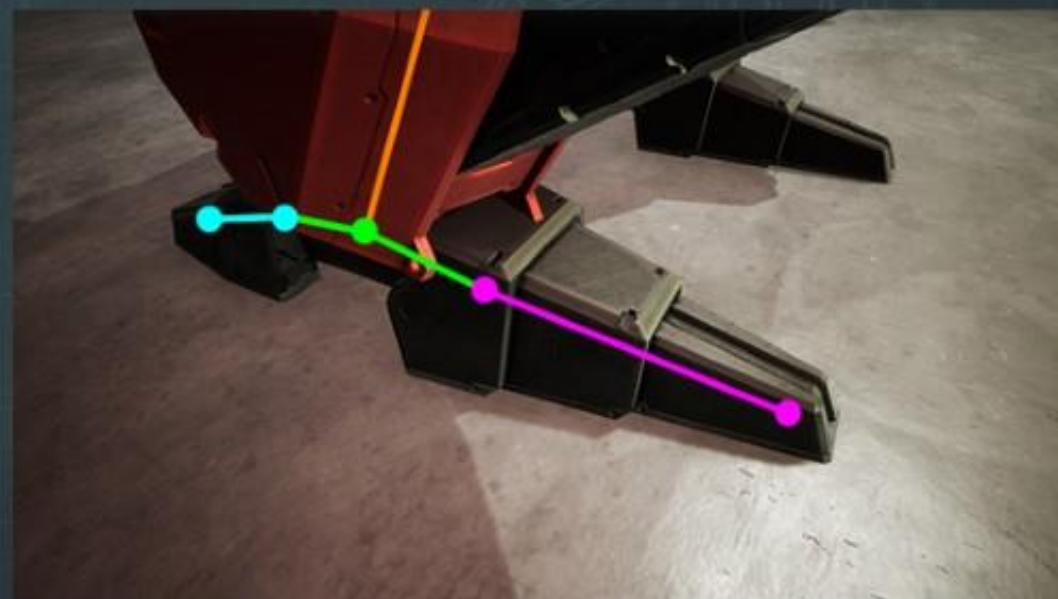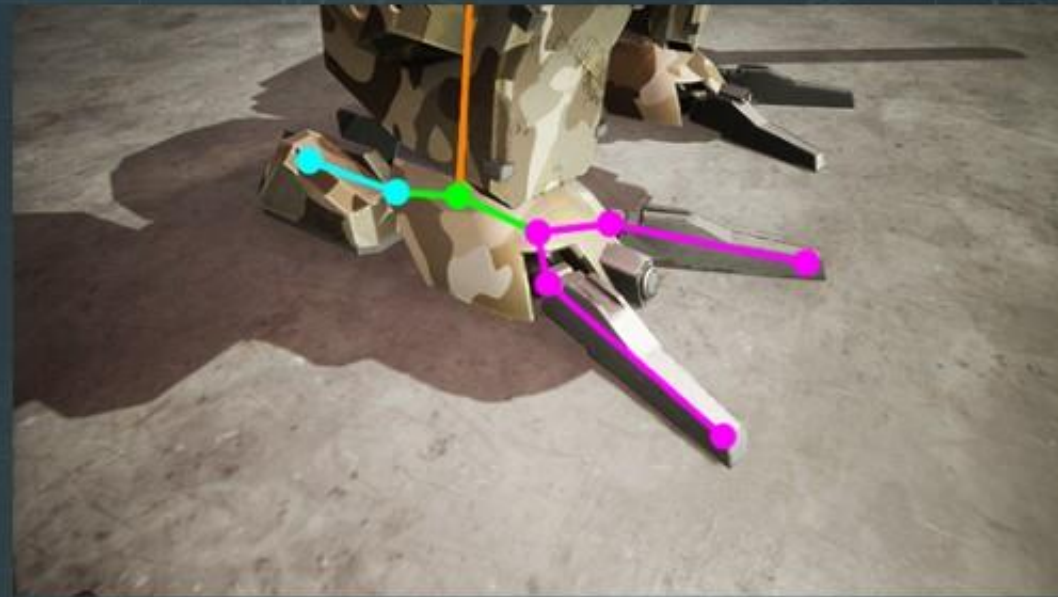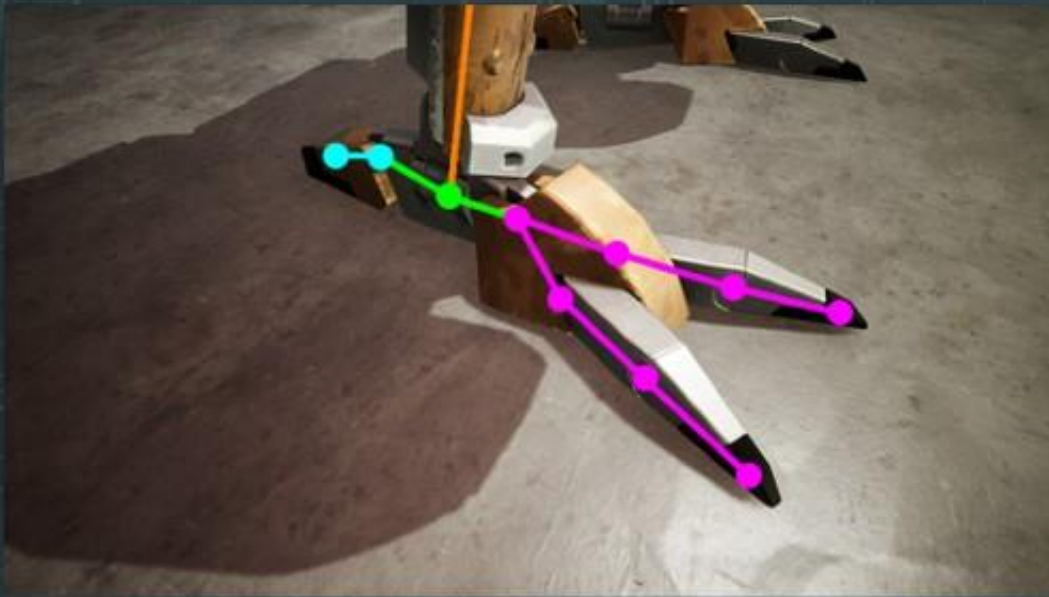
- Ankle
- Toe
- Heel

Walk Animation

- Foot Controller

Exit   Plant   Strike

- **Ankle**
- **Toe**
- **Heel**

Walk Animation

- Foot Control

After Exit → Flying → Before Strike

↑ ↓

Exit ← Plant ← Strike
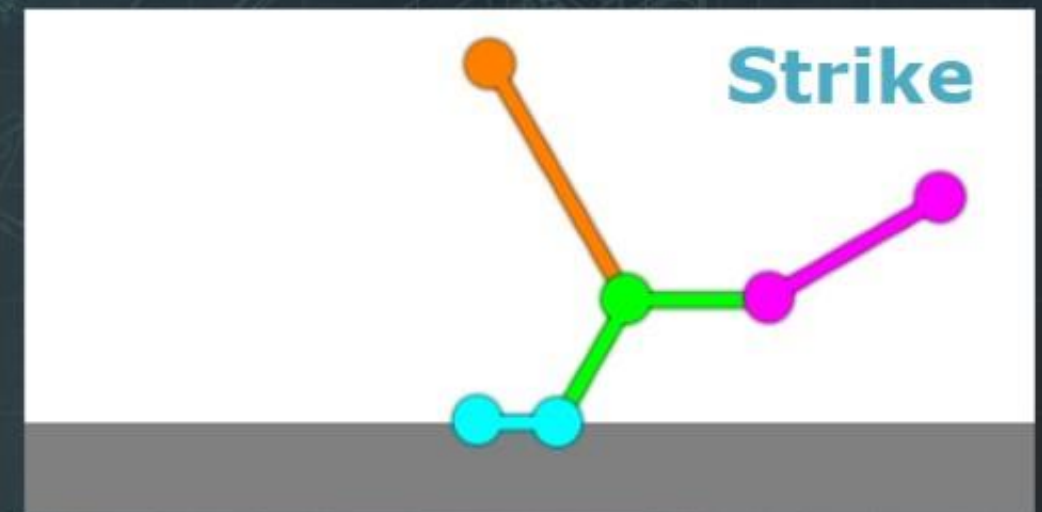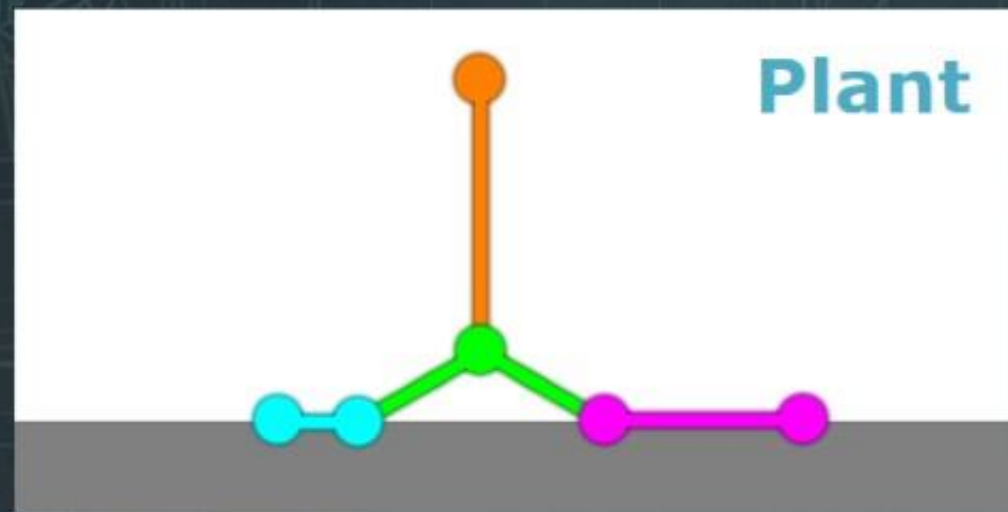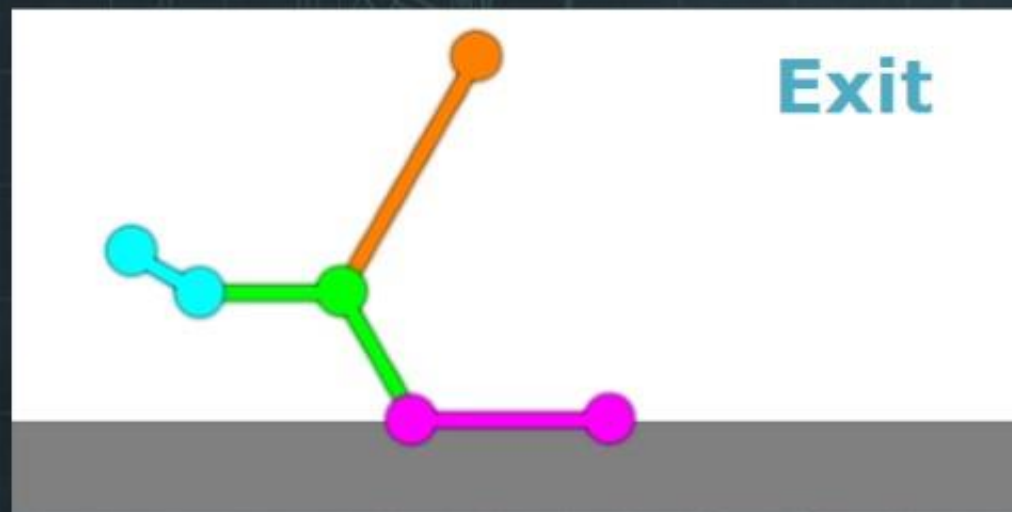
Walk Cycle Status

- Show Walk Cycle

- Show Foot Pose

  - Exit

  - Plant

  - Heel

Walk Cycle

Walk Animation

Link to Movie

Aim Animation

Aim Animation

- Aim Animation is made by blending StartPose and GoalPose

Aim Animation

- AimIK is based on CCDIK
- Find AimPose by repeating this operation at each joint

Aim Animation

- AimIK have Blocking Problem

Failed to Aim

Correct Pose

Aim Animation

- Problem of Blocking

Aim Animation

- Database has AimDatas when each joint is rotated 5 degrees.
  - AimData: Hand Direction, Hand position, ArmJoints rotation
- AimController narrows down by direction, then selects the one with the closest position and direction

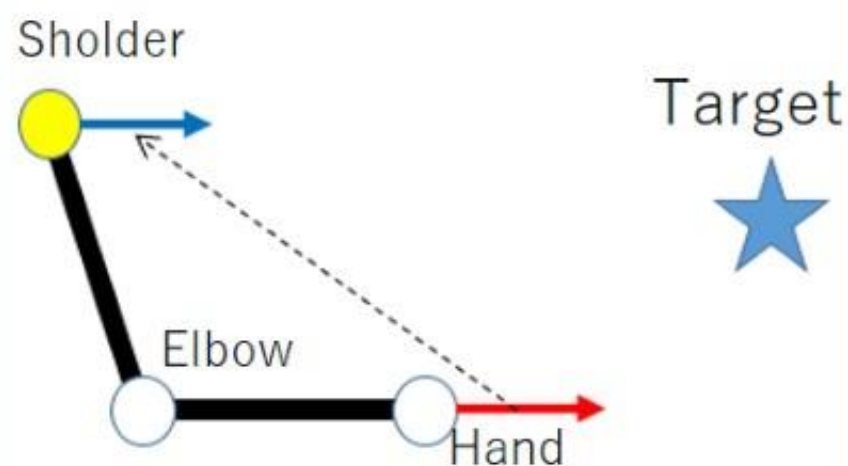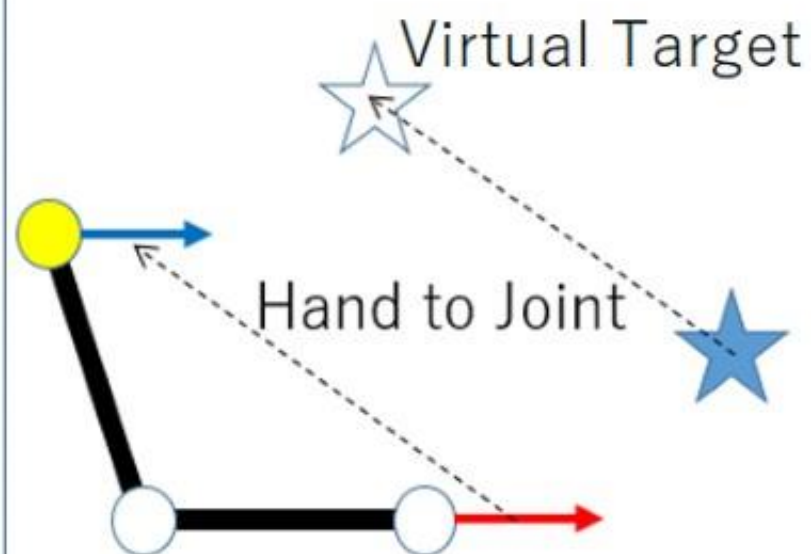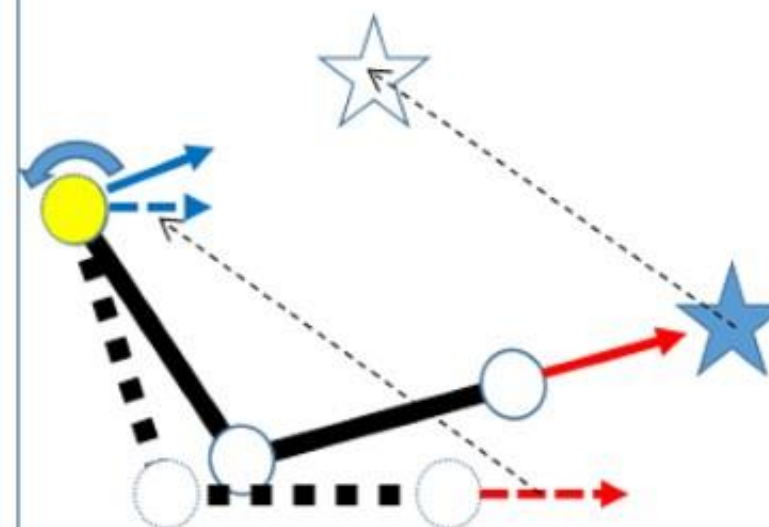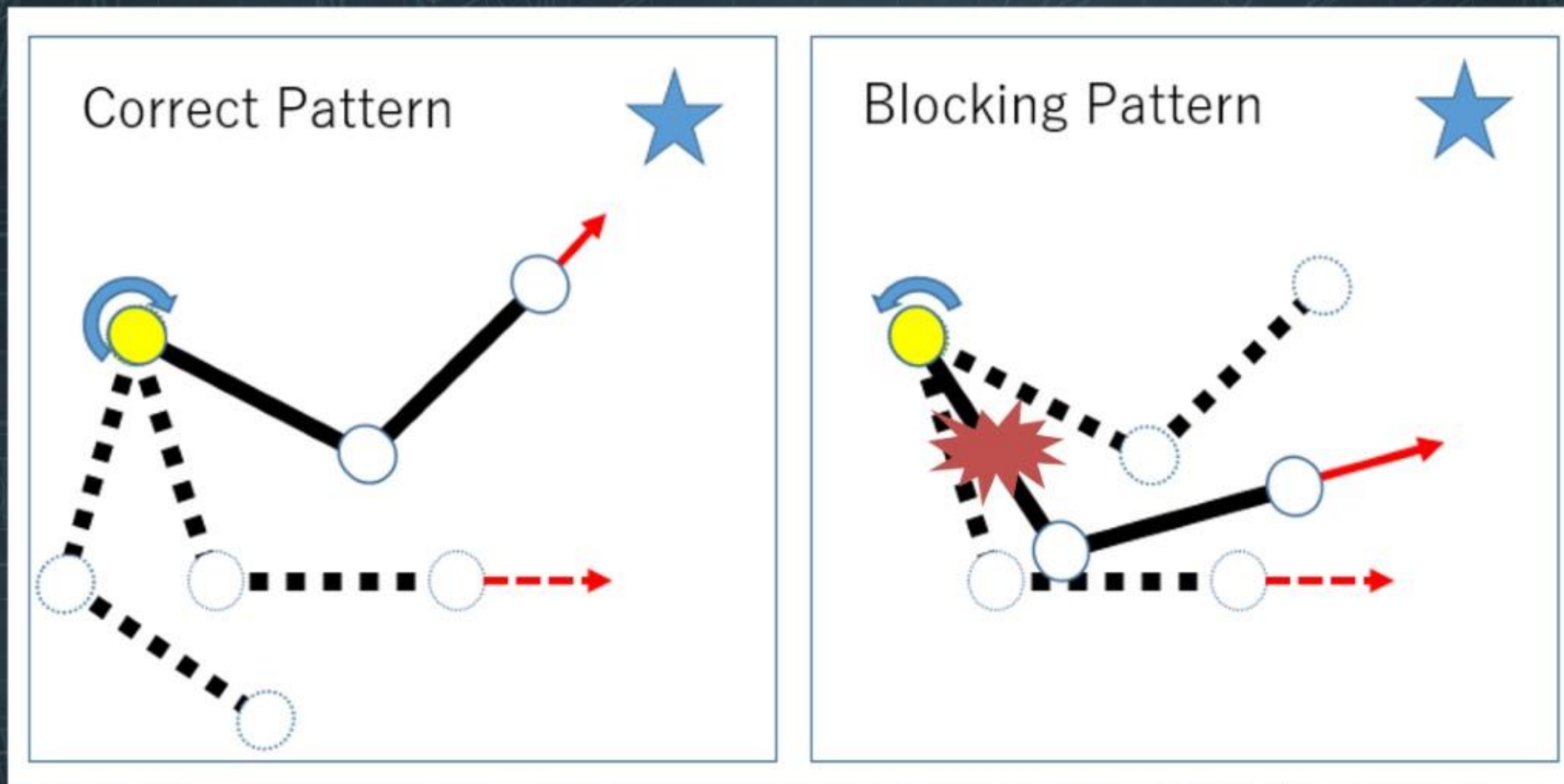|	Theta	Phi	X	Z	Pose
15079	2.026964	0.926826	-291.617279	453.837067	(0.000000,44.999996,20.000002,0.000000,-35.000000,0.000000,0.0000
15080	2.139628	1.079970	-298.499146	446.955170	(0.000000,44.999996,20.000002,0.000000,-24.999979,0.000000,0.0000
15081	2.240073	1.255487	-313.750427	431.703949	(0.000000,44.999996,20.000002,0.000000,-14.999996,0.000000,0.0000
15082	2.323121	1.458384	-387.703217	357.751160	(0.000000,44.999996,20.000002,0.000000,-4.999999,0.000000,0.00000
15083	2.356195	1.570796	-236648208.000000	-236647552.000000	(0.000000,44.999996,20.000002,0.000000,0.000000,0.000000,0.000000
15084	1.209429	0.387596	-271.610046	477.696930	(0.000000,44.999996,30.000000,-44.999996,-44.999996,0.000000,0.00
15085	1.343448	0.504545	-269.951569	479.355347	(0.000000,44.999996,30.000000,-44.999996,-35.000000,0.000000,0.00
15086	1.480286	0.614360	-268.186707	481.120239	(0.000000,44.999996,30.000000,-44.999996,-24.999979,0.000000,0.00
15087	1.618181	0.721460	-266.179718	483.127197	(0.000000,44.999996,30.000000,-44.999996,-14.999996,0.000000,0.00
15088	1.755527	0.829971	-263.717834	485.589081	(0.000000,44.999996,30.000000,-44.999996,-4.999999,0.000000,0.000
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15091	1.480286	0.614360	-272.691711	476.615204	(0.000000,44.999996,30.000000,-35.000000,-35.000000,0.000000,0.00
15092	1.618181	0.721459	-271.483826	477.823120	(0.000000,44.999996,30.000000,-35.000000,-24.999979,0.000000,0.00
15093	1.755527	0.829971	-270.002075	479.304871	(0.000000,44.999996,30.000000,-35.000000,-14.999996,0.000000,0.00
15094	1.890637	0.944177	-268.005707	481.301239	(0.000000,44.999996,30.000000,-35.000000,-4.999999,0.000000,0.000
15095	1.956745	1.004901	-266.667542	482.639435	(0.000000,44.999996,30.000000,-35.000000,0.000000,0.000000,0.0000
15096	1.480286	0.614360	-276.676636	472.630280	(0.000000,44.999996,30.000000,-24.999979,-44.999996,0.000000,0.00
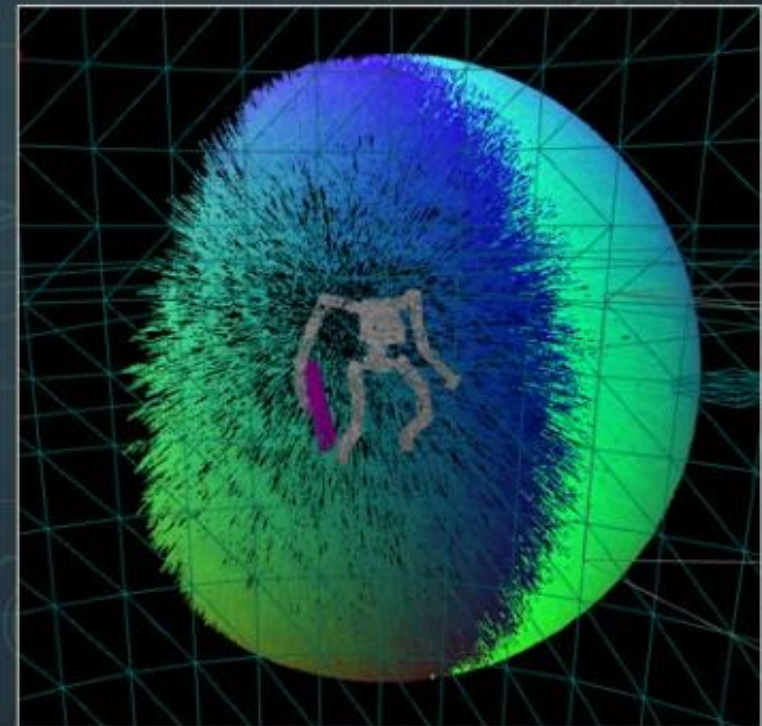
Aim Animation

Summary

Summary of Implementation

- FullProceduralAnimation is able to attach various robot models.

- Walk Animation was realized by putting FootStep and moving IK targets.

- Aim Animation was realized by searching AimPose and using AimIK.

Problem

- Memory, CPU cost
  - calculate CCDIK every frame
  - Walk animation need RayCast many time
  - If the model's arm has many joints, AimDataBase becomes very large database

Problem

- Can't select Pose
  - If the angle limit is wide, character takes mysterious pose.
  - In AimAnimation, We can't control gun rotation.

Future

- Evaluation of Pose
  - Pose Scoring
  - Pose Selection

- Support for other joint structure models
  - 4 feet
  - Fixed arm
  - etc.

Summary

- We developed FullProceduralAnimation system for Customized Mech's Model.
    - Using Traditional Approach(FK, IK, Pose Searching)
- MULS generates animation and can be attached to various humanoid mech models

- Not yet production ready
- We'll focus on solving the problems and expanding functionality

Thank you for watching!

Related Session

Tuesday, July 20 2:00pm – 2:30pm

GDC

AI Summit

Advanced Real-Time Hierarchical Task Networks
A New Approach

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