AI-powered Immersive Virtual Reality (VR)

Yasunobu Uchiyama (Rikkyo University & Galaxies, inc.)

ISCO2023, OIST in Okinawa, Japan, 27th Feb. — 3rd March

RIKKYO UNIVERSITY
Graduate School of Artificial Intelligence and Science

Introducing myself…

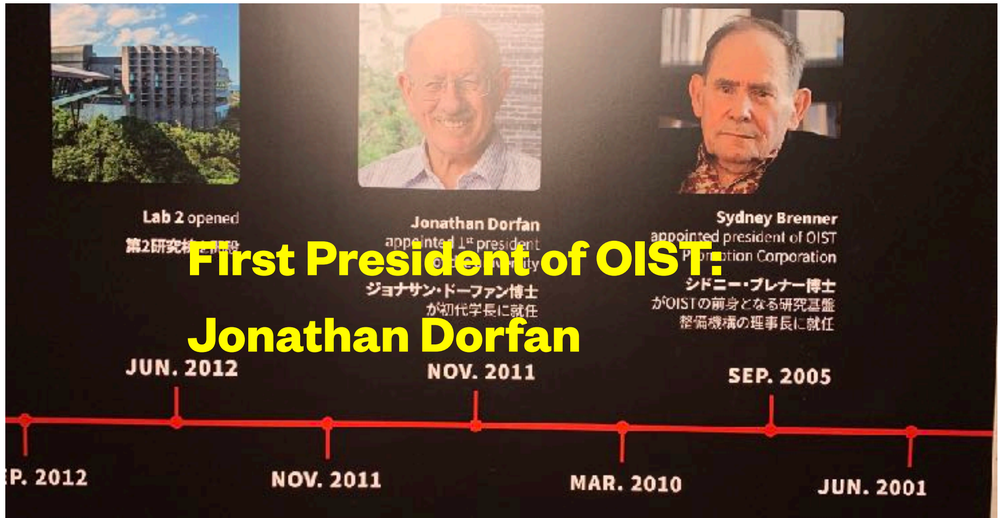
2003:
Received Ph D. from Univ. of Tokyo
in X-ray Astronomy
(Supervisor: Prof. Tad Takahashi)

2008—2013:
Panofsky Fellow at SLAC (Stanford)
in Gamma-ray Astronomy

2016—present:
Professor at Rikkyo U.
High-Energy Astrophysics

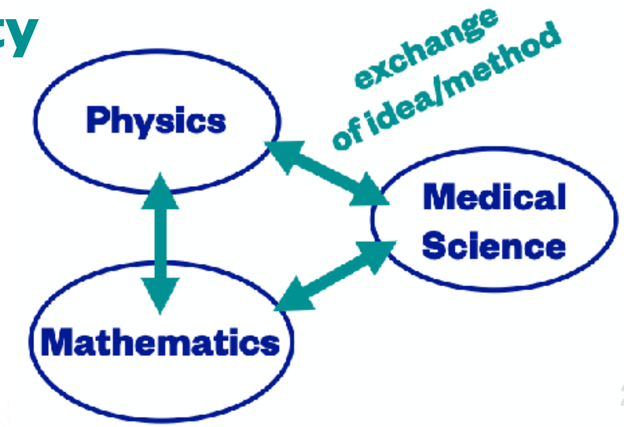
2018—present:
Founder of Galaxies, inc.
in **AI & VR**

2020—present:
Founder & Chair
of **Rikkyo Graduate School of AI and Science**



First President of OIST:
Jonathan Dorfan

Interdisciplinarity



Interdisciplinary and Transdisciplinary

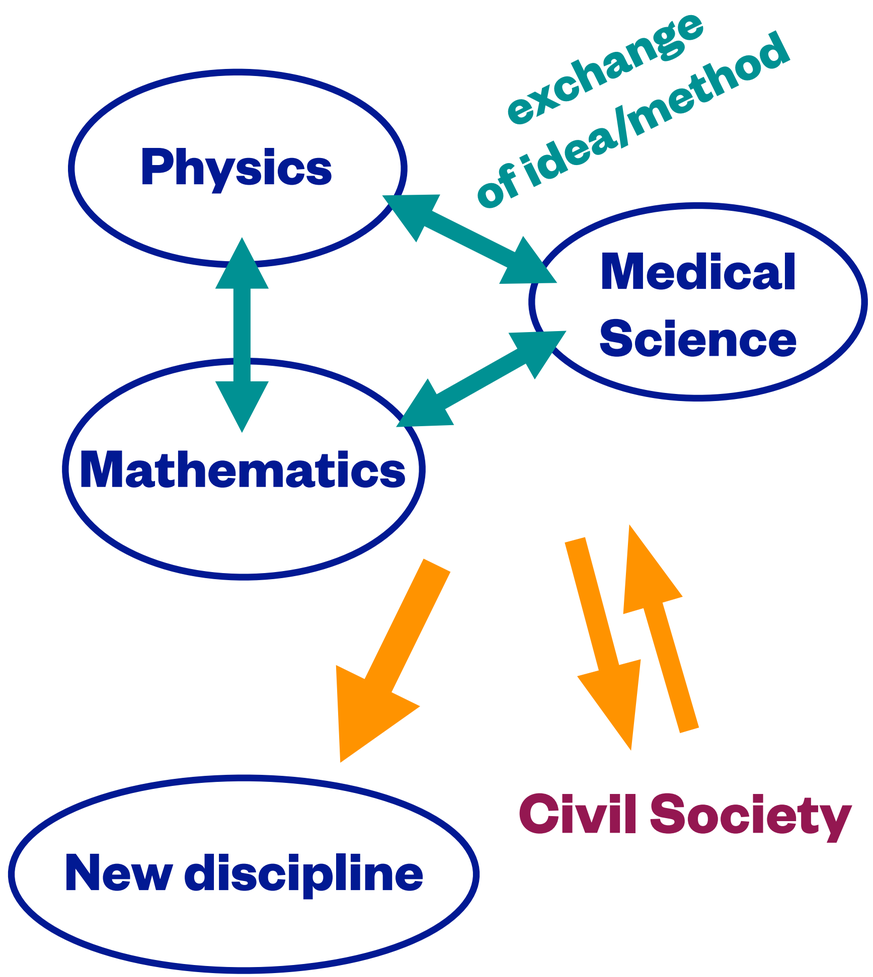
According to “The Application of Transdisciplinary Theory and Practice to STEM Education” (S. M. Back, H. Greenhalgh-Spencer, K M. Frias):

Interdisciplinarity

A joint effort to solve a problem or develop a product in which experts from different disciplines exchange theories and methods in a process of sharing their areas of expertise.

Transdisciplinarity

A fusing of theories, methods and expertise across disciplinary boundaries in which each discipline merges with the others in the formation of a whole that is greater than the sum of its parts. **New disciplines** may emerge as in the case of the “New Biology” which is the result of collaborative efforts on behalf of traditional biology, physical and chemical sciences, computational science, mathematics, and engineering. Transdisciplinarity may also include perspectives and methods from such disciplines as social science, economics, and public administration as well as from **civil society and a wide range of stakeholders.**



1. What AI can do today

Some examples

RESEARCH ARTICLE

Superhuman AI for multiplayer poker

Noam Brown[1,2,*], **Tuomas Sandholm**[1,3,4,5,*]

[1]*Computer Science Department, Carnegie Mellon University Pittsburgh, PA 15213, USA.*

[2]*Facebook AI Research New York, NY 10003, USA.*

[3]*Strategic Machine, Inc. Pittsburgh, PA 15213, USA.*

[4]*Strategy Robot, Inc. Pittsburgh, PA 15213, USA.*

[5]*Optimized Markets, Inc. Pittsburgh, PA 15213, USA.*

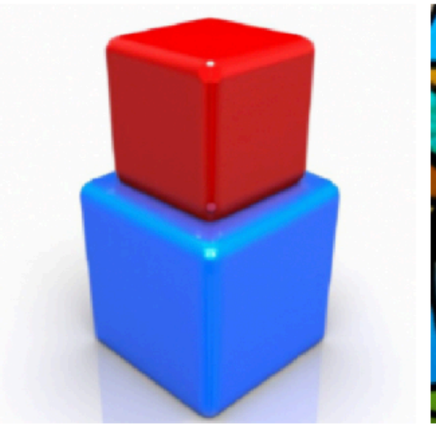
↵*Corresponding author. E-mail: noamb@cs.cmu.edu (N.B.); sandholm@cs.cmu.edu (T.S.)

– Hide authors and affiliations

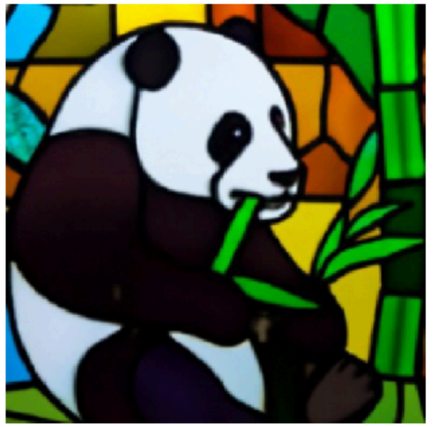
Science 11 Jul 2019:
eaay2400
DOI: 10.1126/science.aay2400

GLIDE: Towards Photorealistic Image Generation and Editing with Text-Guided Diffusion Models

"a painting of a fox in the style of starry night"



"a red cube on top of a blue cube"



"a stained glass window of a panda eating bamboo"

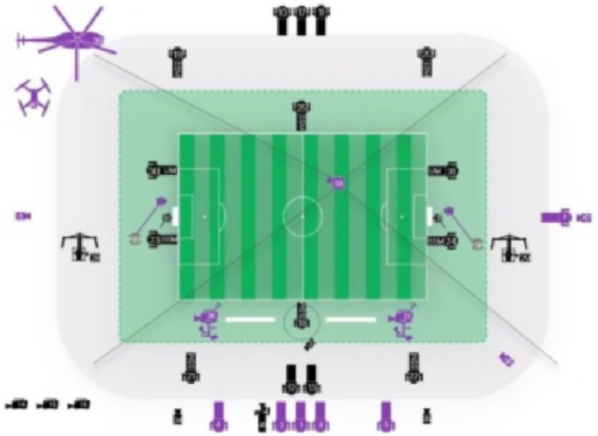
Nichol et al. (2021)

Stable Diffusion (2022)

AI Technologies in World Cup

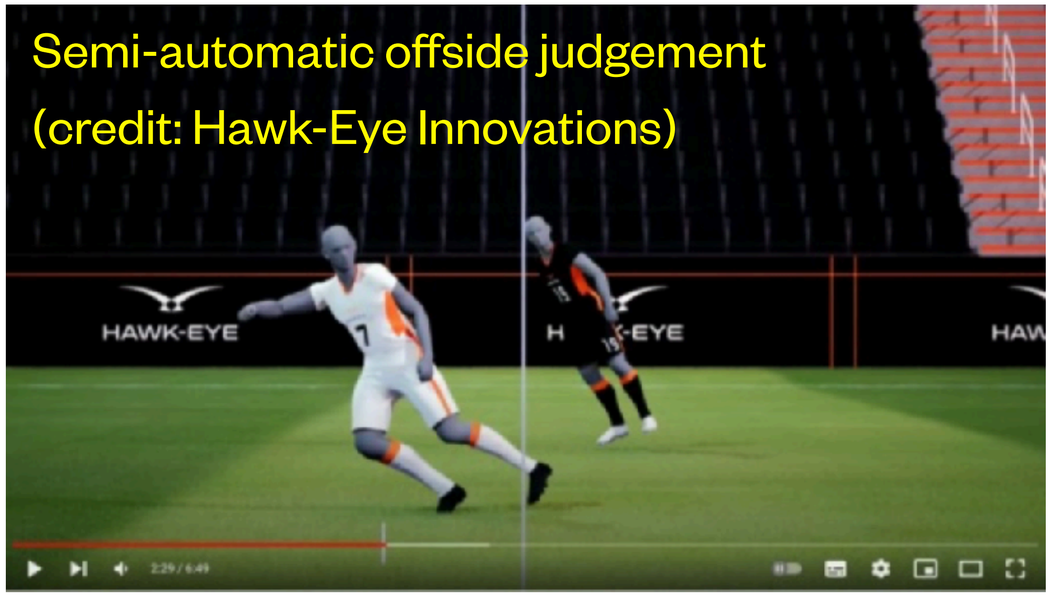
42 cameras for **Qatar World Cup** (2022)

credit: FIFA



Semi-automatic offside judgement

(credit: Hawk-Eye Innovations)



To track movement and posture of each player, 3D positions of 29 joints are estimated (every **~0.1 sec**) by **machine learning** from video (Hawk-Eye Innovations)

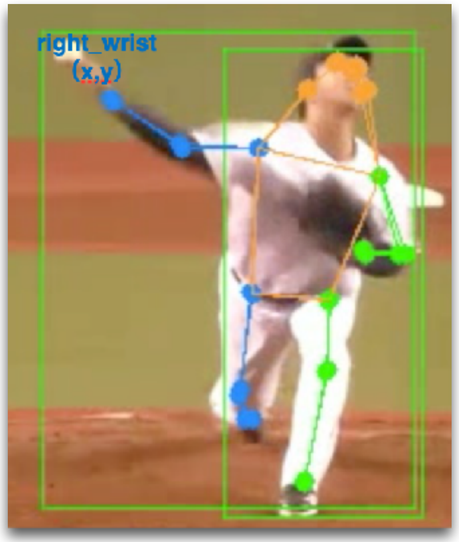
2. Rikkyo-AI Projects

Applied AI in Professional Baseball (Preview)

RIKKYO AI

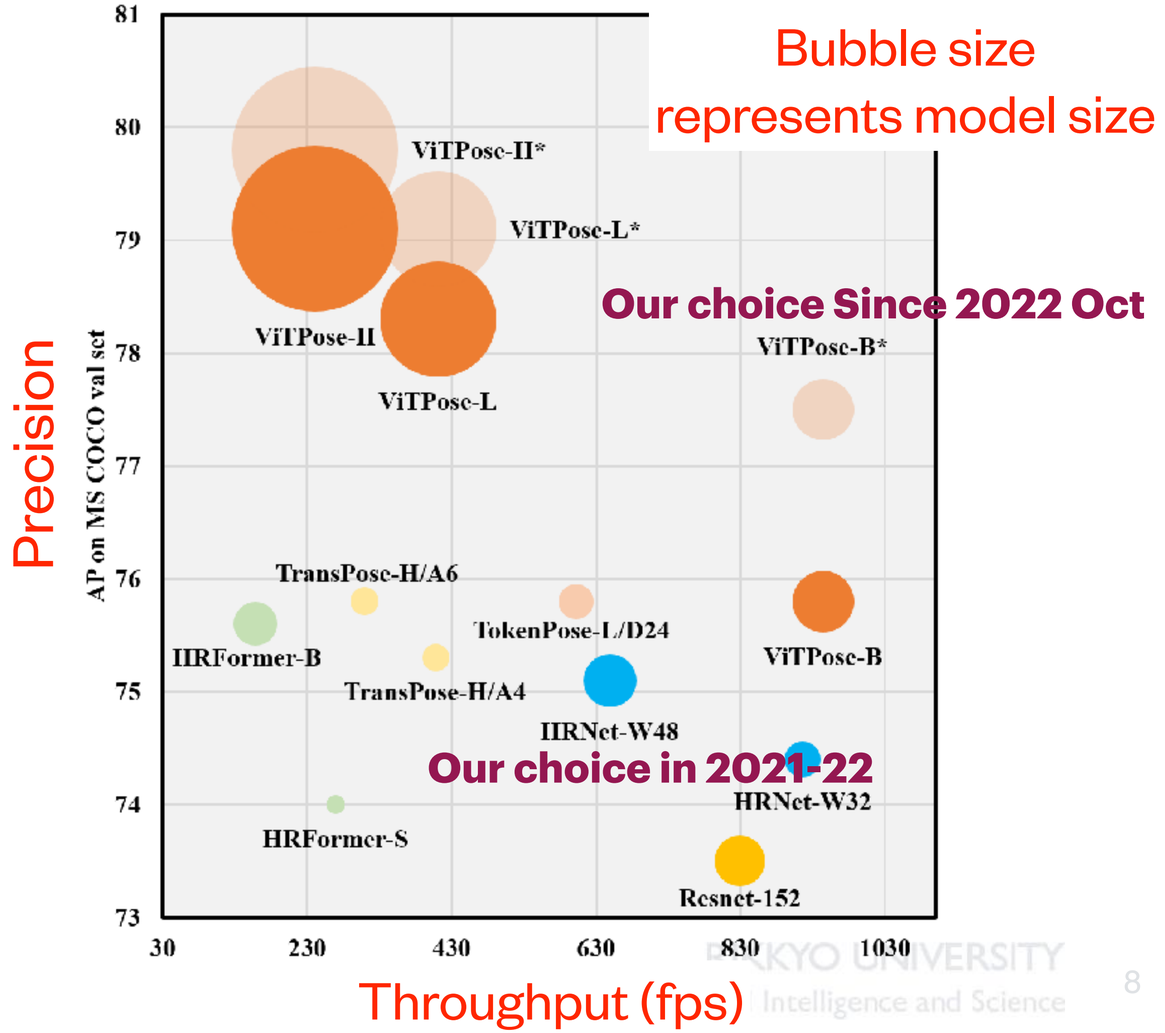
RIKKYO AI x Saitama Seibu Lions

(**Not** Samsung Lions…)



Pose estimate AI: estimate the positions of 17 joints (keypoints) such as wrists, elbows, and shoulders from a single camera taking pitcher's motion.

ViTPose: Simple Vision Transformer Baselines for Human Pose Estimation (Xu et al. **2022 October**)



Applied AI in Nursing Care

Smile Project: using AI/VR/robots, we try to increase the **smiles** of elderly people living in special nursing homes.

This project is a joint **industry-academia project** among NTT East Japan, Social Welfare Corporation: Frontier, and Rikkyo University Graduate School of Artificial Intelligence Science.

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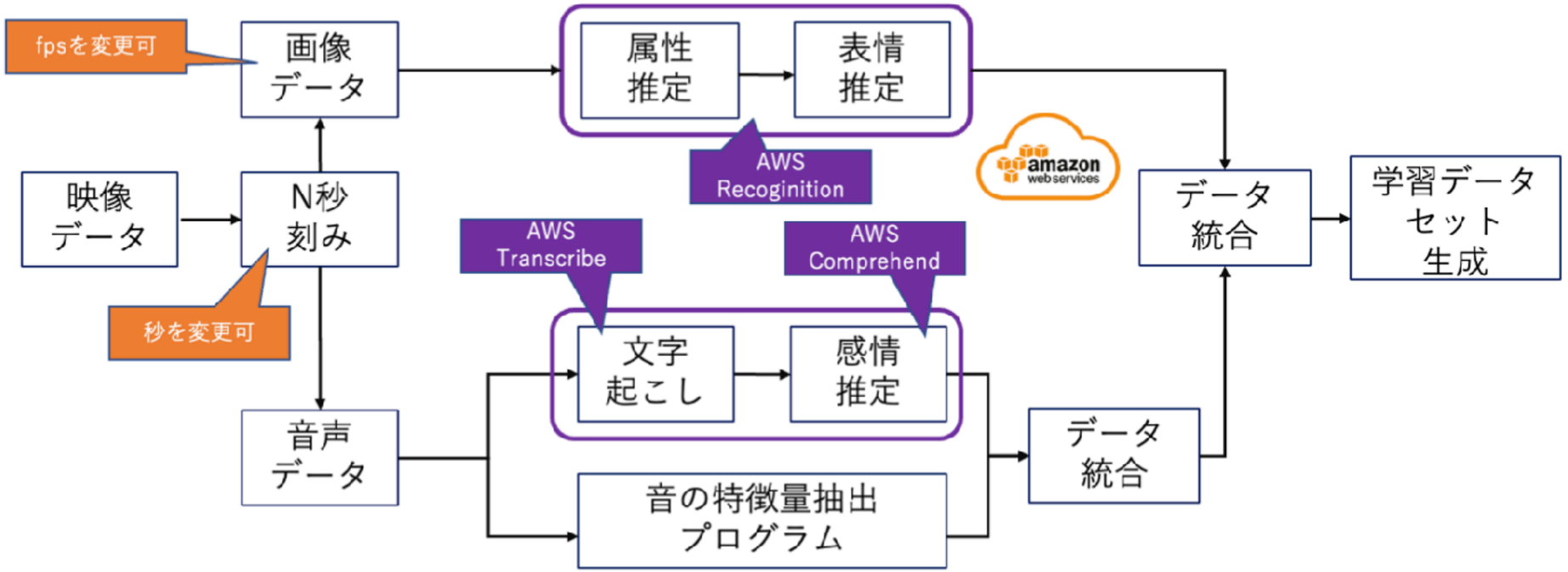

図 2-4　学習データ生成システム概要

3. Immersive Virtual Reality

Virtual Reality (VR)

(credit: Meta Platforms)

(stereo) Head-mounted Display (HMD)

Key elements of (immersive) VR

- **3D** spatiality
- Real-time interaction (able to **act freely** in the created environment)
- Self-projectiveness (**immersion** in the created environment)

VR Device and Software

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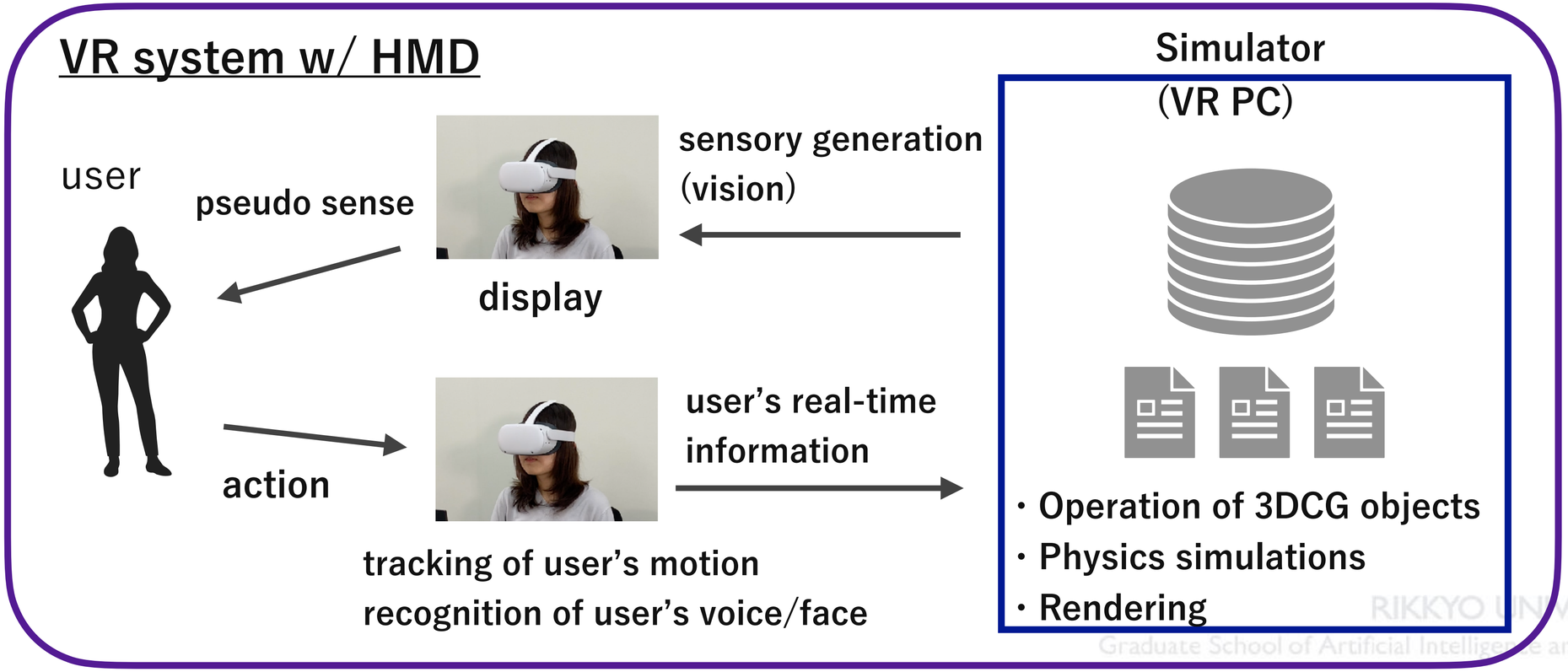
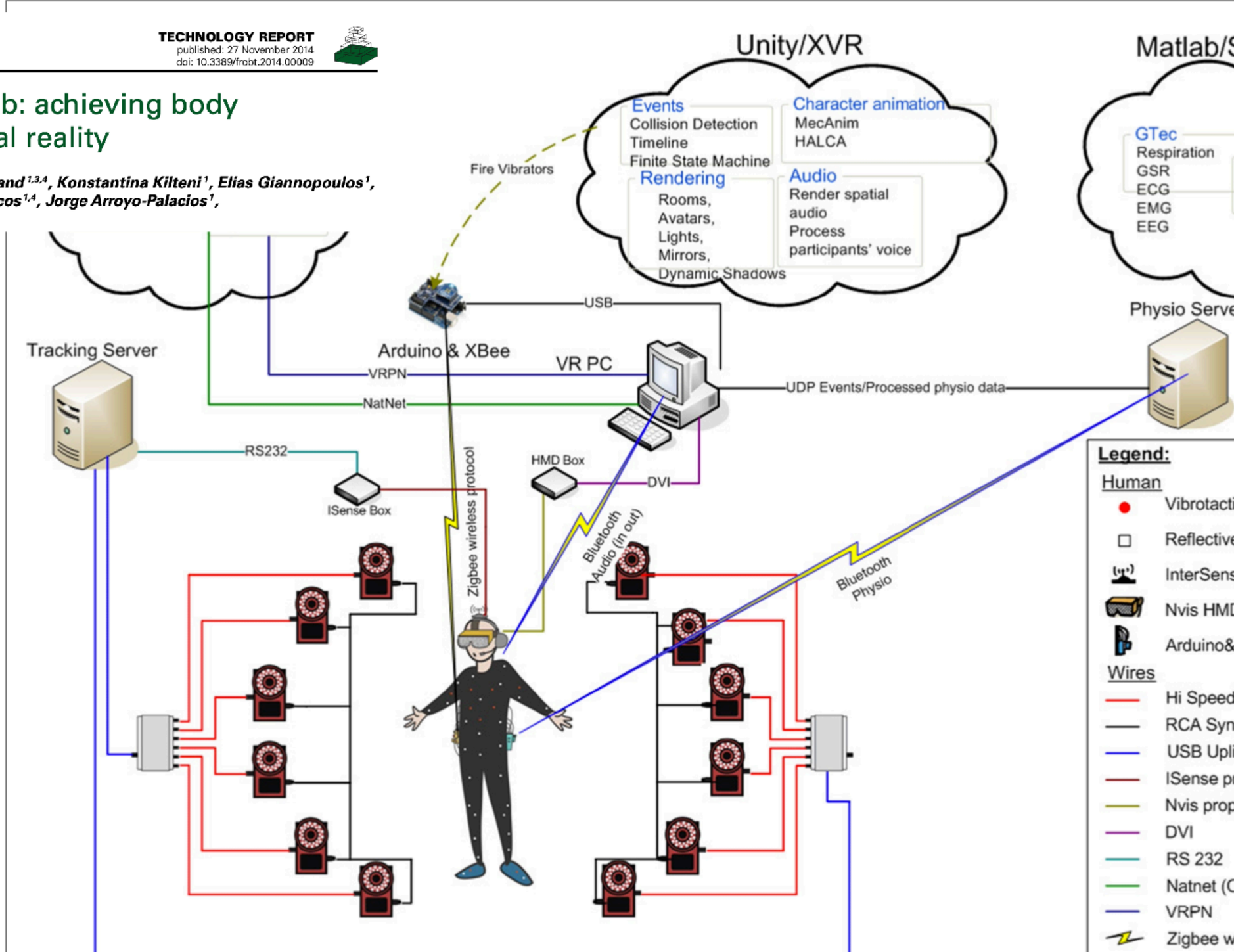


frontiers in
ROBOTICS AND AI

TECHNOLOGY REPORT
published: 27 November 2014
doi: 10.3389/frobt.2014.00009

How to build an embodiment lab: achieving body representation illusions in virtual reality

*Bernhard Spanlang[1], Jean-Marie Normand[1,2], David Borland[1,3,4], Konstantina Kilteni[1], Elias Giannopoulos[1], Ausiàs Pomés[1], Mar González-Franco[1], Daniel Perez-Marcos[1,4], Jorge Arroyo-Palacios[1], Xavi Navarro Muncunill[1] and Mel Slater[1,5]**



Avatar and Virtual Embodiment

RIKKYO AI

Avatar

(c

Virtual Embodiment

- Body Ownership
- Agency

Powered by AI

UIST '21, October 10–14, 2021, Virtual Event, USA Fang et al.

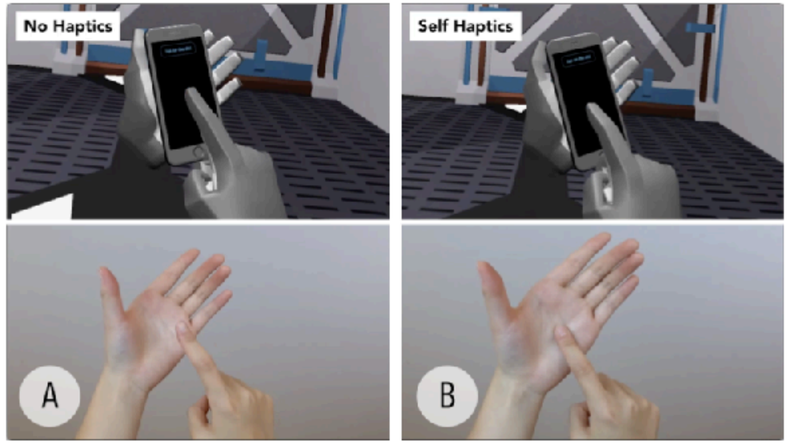


Figure 4: The user's index finger taps on a smartphone screen either feels (a) nothing and pass through the 3D model of the phone or (b) self-haptics, where the finger is stopped by the palm, creating the sensation of a surface, while the phone-holding hand feels the appropriate downward impulse from finger taps.

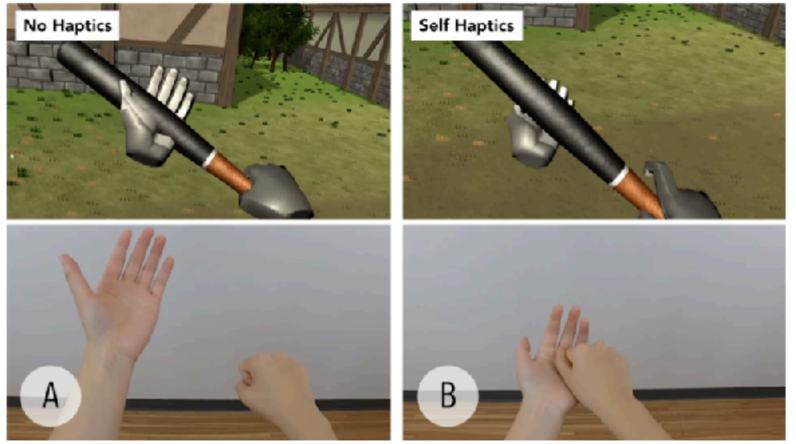


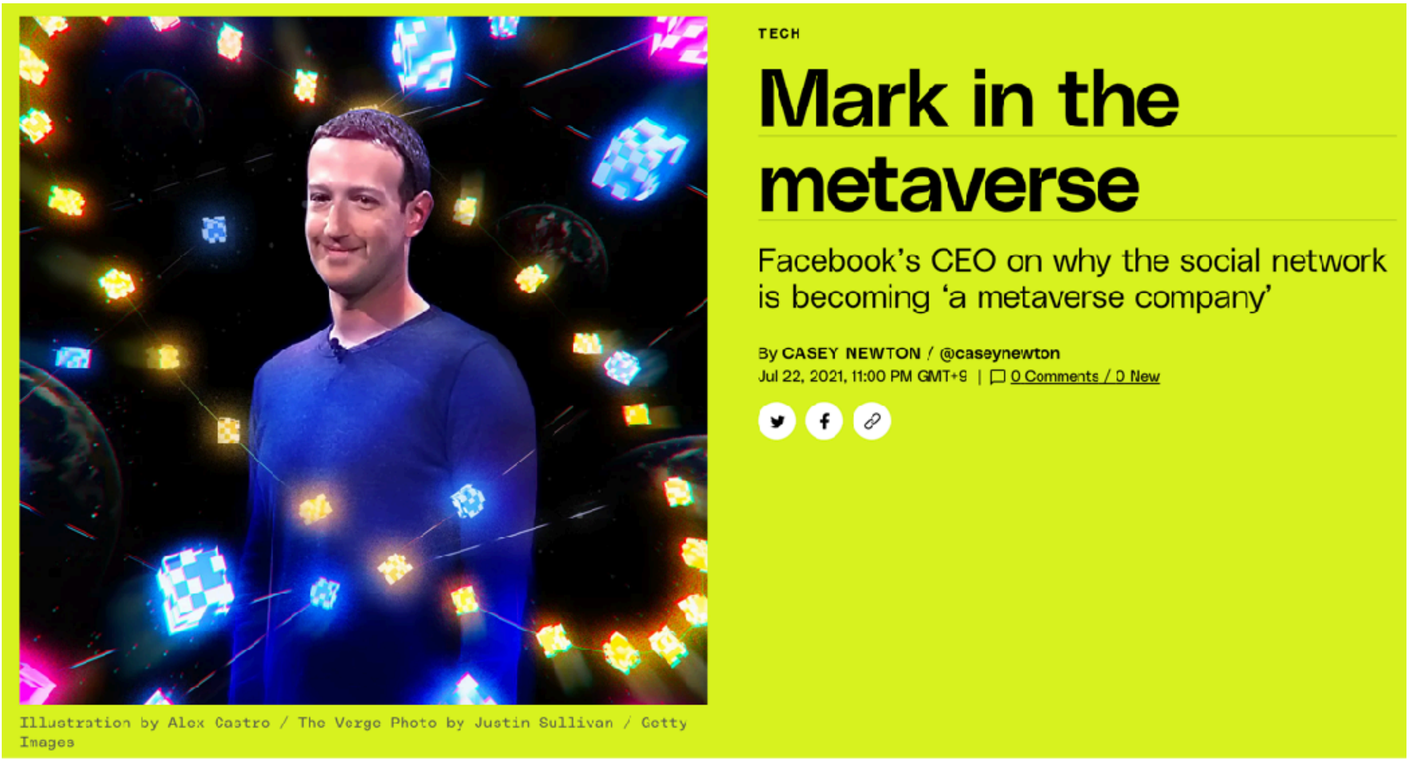
Figure 6: The user swings a baton and receives either (a) no haptic feedback or (b) self-haptics where the fist falls into the other hand, simulating the impact of the baton swing.

feel appropriate. We built such a bow and arrow demo, where the user's left hand holds a bow, which we retarget such that we place

Metaverse *“Embodied Internet”*

“The ‘metaverse’ is a set of virtual spaces where you can create and explore with other people who aren’t in the same physical space as you.”

Meta Platforms (formally Facebook)

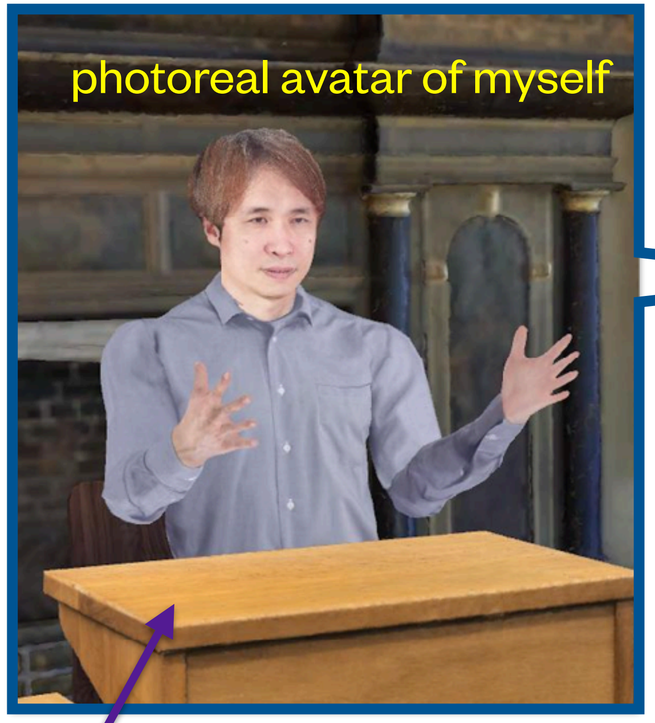


4. AI x VR

Recent **AI** revolution leading to **VR** revolution

“Real” Avatar in “Real” Environment

With the advent of high-performance device (HMD) and revolutionary powerful **AI** technologies (deep learning), it becomes possible for VR to be more and more “**real**”.



a photoreal desk of our classroom
(reconstructed from its pictures)

Avatars of Hatsuda-san & Nagataki-san

Photogrammetry:
Combining images from ~50 cameras surrounding a person, 3D photorealistic model can be generated.

→ “classical” computer vision technique

AI (Deep Learning) can improve the 3D model:

- image inpainting
- mesh optimization
- etc.

In the near future,
deep learning may take over from current photogrammetry algorithm.

Transformation of Virtual Body and Objects

IEEE Transactions on Pattern Analysis and Machine Intelligence

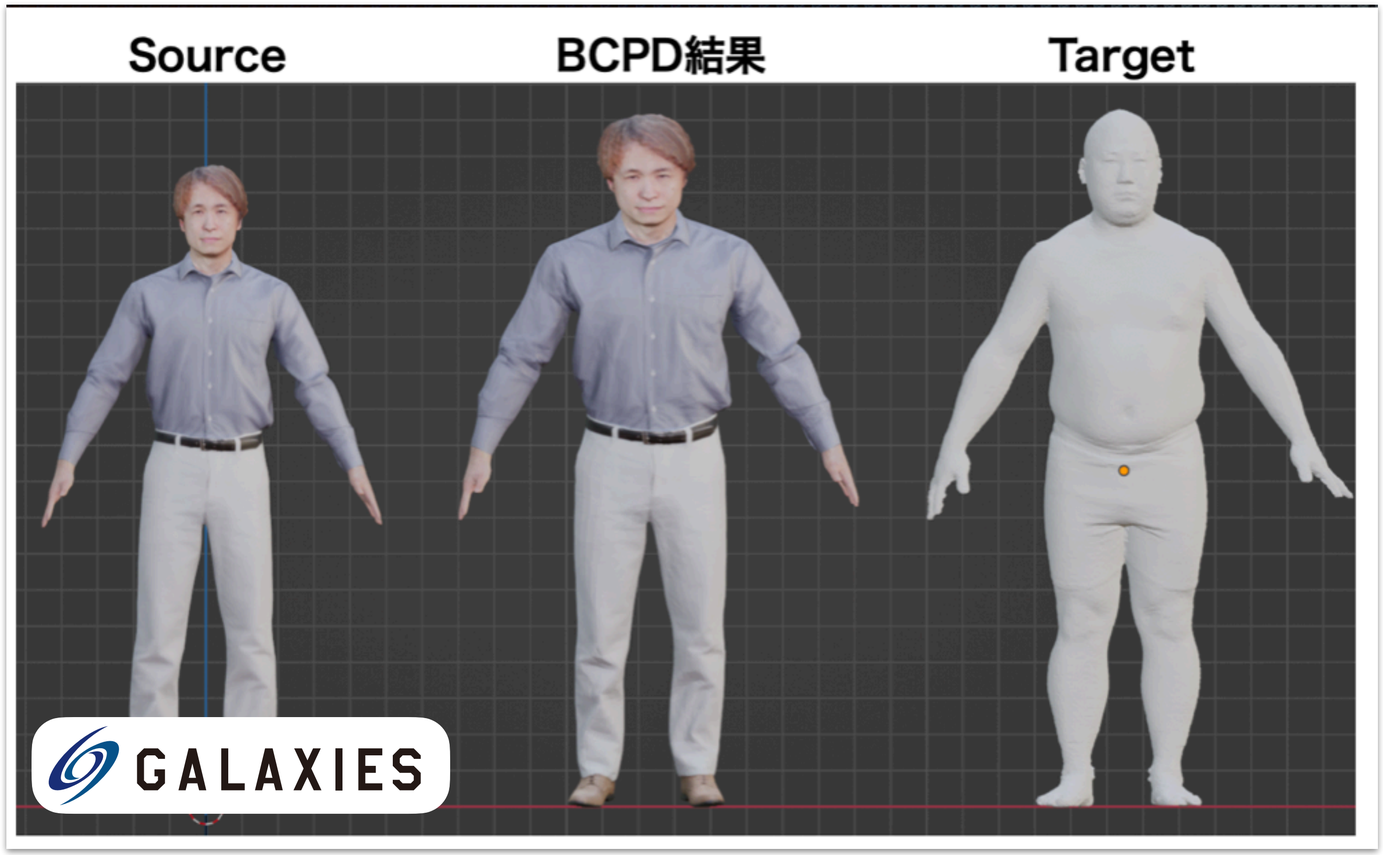
A Bayesian Formulation of Coherent Point Drift

July 2021, pp. 2269-2286, vol. 43
DOI Bookmark: 10.1109/TPAMI.2020.2971687

Authors

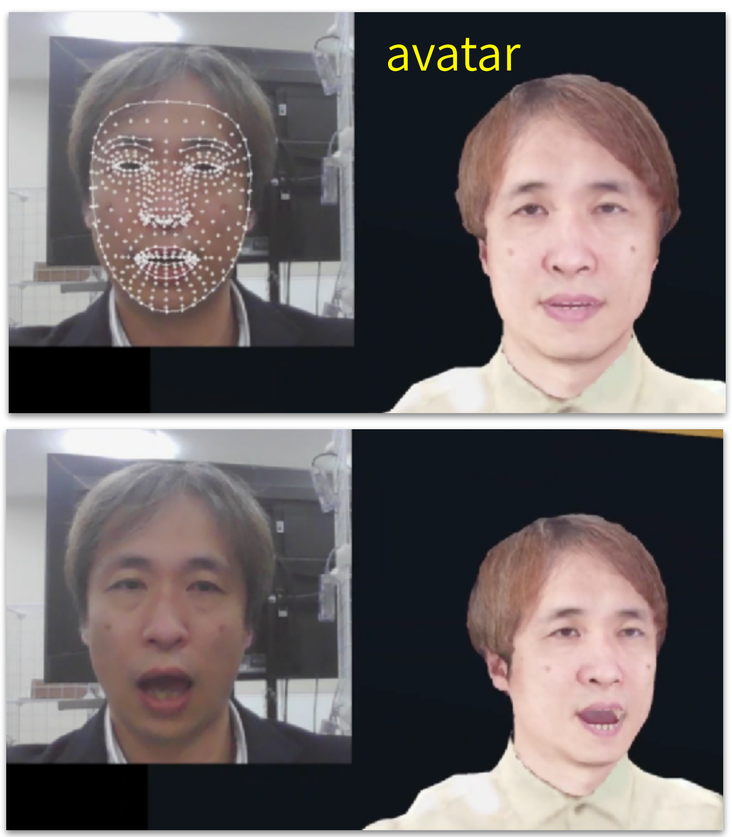
Osamu Hirose, Institute of Science and Engineering, Kanazawa University, Kakuma, Kanazawa, Ishikawa, Japan

Bayesian Coherent Point Drift

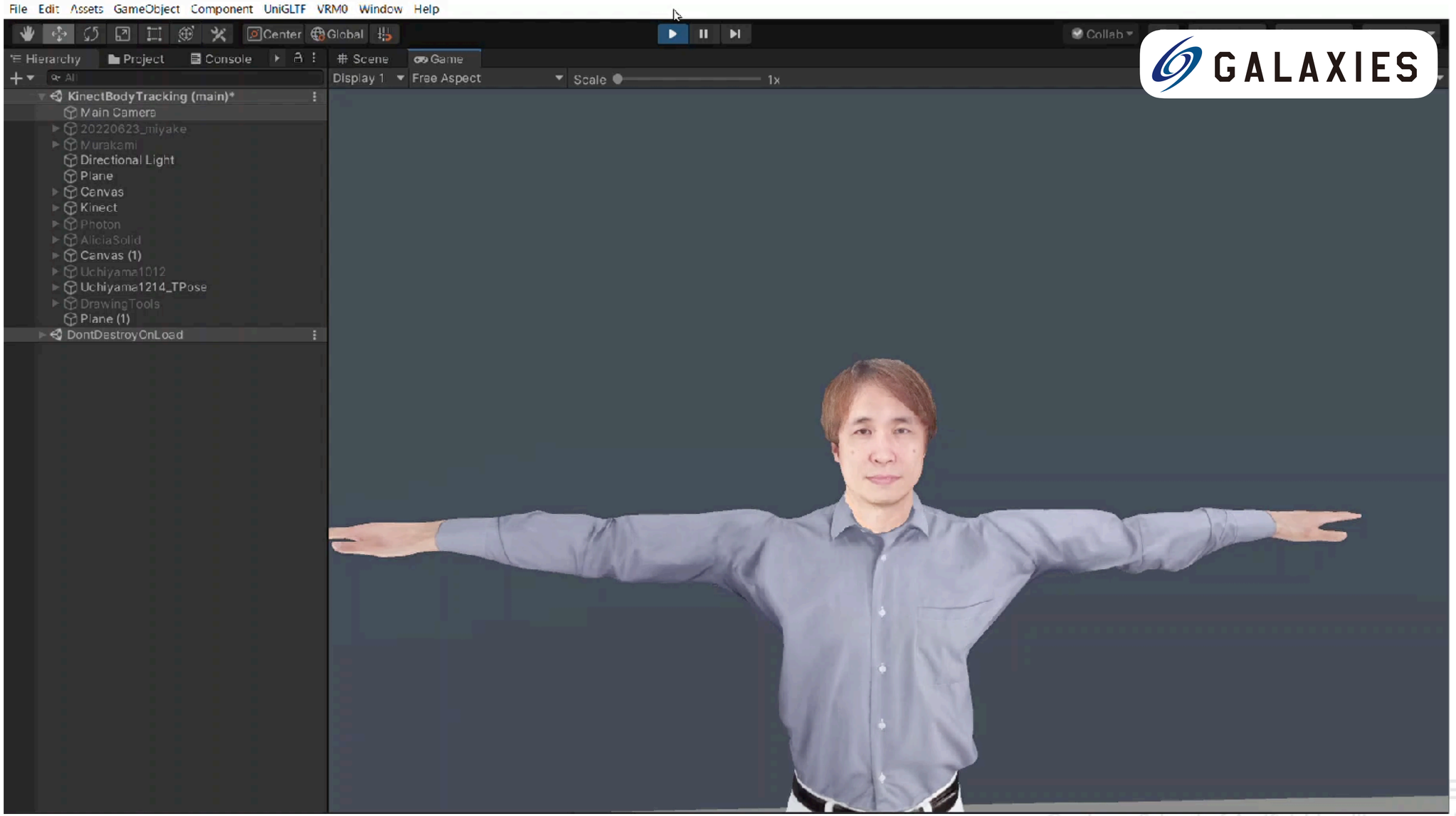


A. Hayashi (OIST, grad student) is working on this in my company (Galaxies, inc.)

Facial Expression Synchronization



Posture Synchronization

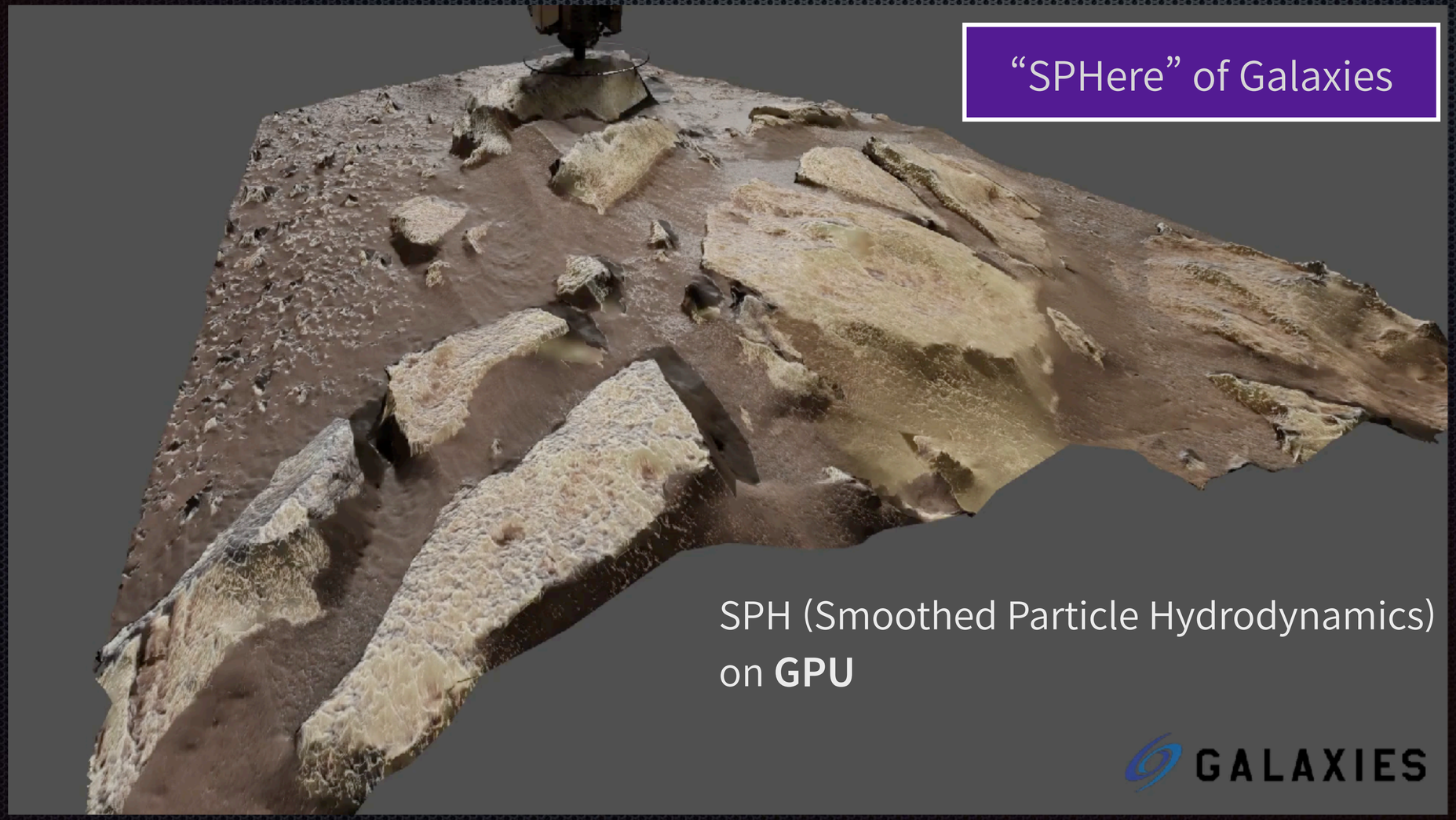


GALAXIES

SPH Simulation for VR

Smoothed Particle Hydrodynamics (SPH) Simulation

→ Deep Learning may realize much faster, **real-time**, simulation



AI x VR (overview)

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