Industrial Robots for Everyone!

rosen.diankov@mujin.co.jp
Why Japan?

• 50% of industrial robots are Japanese
• Sushi
Mujin Origins

- Founded and managed OpenRAVE (8+ years)
  - Started at CMU Motion Planning Group (James Kuffner)
  - Planned for 1000+ robots
- Postdoc at Univ of Tokyo JSK Lab (Masayuki Inaba, Kei Okada)
- Co-founded with genius Japanese sales engineer in 2011
- Initial core team joined in 2012 (MIT, RPI)
- Today: Selling motion planning products and scaling!

Customer Feedback Drives Technology Progress

rosen.diankov@mujin.co.jp
Industrial Robots Increase Manufacturing Productivity

- Engine Assembly
- Real-time Bin-picking
- Simultaneous Dual-arm Planning
- Part Inspection
- Dual-arm Fluid Manipulation
- 7-DOF Planning

rosen.diankov@mujin.co.jp
Mujin Product Strategy

1. Replace offline teaching with cloud services

2. Offer new applications with Mujin Controller
Importance of Bin-picking
Mujin Binpicking

- https://www.youtube.com/watch?v=U_t04fC7L9U
Arm Motion Planning Technologies

- COLLADA (ISO standard)
- Industrial Task Language (ITL)
Robotics via HTTP

- Standardized on ISO/open 3D asset formats
  - 5 years writing all the infrastructure
- RESTful Web API for Motion Planning
  - 2 years of trial-and-error
  - Outside systems can easily integrate using any platform/language
- Browser
  - WebGL
Product
Mujin Controller: World’s First Commercial Motion Controller for Factory Automation

3D models + high level task specification ➝ robot programs

Industrial Task Language (ITL)

- Create fast, efficient, and collision-free robot programs, for any robot
- 95%+ accuracy for real robot (<60% for other commercial simulators)
- Industrial Task Language
  - model any task
- Layout optimization
  - impossible without motion planning
- Browser interface with interactive 3D visualization

Browser interface with WebGL
Industrial Task Language (ITL) (pick-and-place)

```plaintext
1 Set(tool, 1)
2 Set(clearance, 0)
3 Move(Translate(0, 0, 120)*p[pickup_jagariko1])
4 MoveL(p[pickup_jagariko1])
5 Grab(t[jagariko1])
6 MoveL(Translate(0, 0, 120)*p[pickup_jagariko1])
7 Move(Translate(0, 0, 120)*p[P1])
8 MoveL(p[P1], accuracy_dist=0.1)
9 Release(t[jagariko1])
10 MoveL(Translate(0, 0, 120)*p[P1])
11 Move(Translate(0, 0, 120)*p[pickup_jagariko2])
12 MoveL(p[pickup_jagariko2])
13 Grab(t[jagariko2])
14 MoveL(Translate(0, 0, 120)*p[pickup_jagariko2])
15 Move(Translate(0, 0, 120)*p[P3])
16 MoveL(p[P3], accuracy_dist=0.1)
17 Release(t[jagariko2])
18 MoveL(Translate(0, 0, 120)*p[P3])
```

rosen.diankov@mujin.co.jp
ITL Multi-robot

1 # grab tool with right arm
2 Set(tool, rightarm_torso)
3 move(p[mountpoint1])
4 grab(t[hand1])
5 move(translation(0,0,80)*p[mountpoint1])
6 # grab tool with left arm
7 Set(tool, leftarm_torso)
8 move(p[mountpoint2])
9 grab(t[hand2])
10 move(translation(0,0,70)*p[mountpoint2])
11 # grab the assembly with left hand
12 Set(tool, tool1)
13 move(translation(0,0,20)*p[P7])
14 movel(p[P7])
15 grab(t[assembly_plate])
16 move(translation(0,0,50)*p[P6])
17 movel(translation(0,0,30)*p[P6])
18 release(t[assembly_plate])
19 movel(translation(0,0,50)*p[P6])
ITL Compilation Graph
Who are we?

Senior Team:

- **Professor Takeo Kanade**
  - Chief of Robotics Institute at Carnegie Mellon University (-2001)
  - Chief of Quality of Life Technology Center (2006-)
  - Mentor of James Kuffner

- **Rosen Diankov** CTO
  - B.S., University of California, Berkeley (2006)
  - JSPS Postdoctoral Fellow, The University of Tokyo (2012)
  - OpenRAVE - Founder and Active Developer (2007-)

- **Huan Liu** Chief of Software Development
  - B.S., MEng, MIT (2011)
  - Bilibot - Co-founder (2011)
  - Oracle America - Software Engineer (2012)

Advisors:

- **Professor Masayuki Inaba**
  - Head of JSK robotics lab, The University of Tokyo
  - Graduated 300 students currently holding key positions in major Japanese companies

- **Professor Takeo Kanade**
  - Chief of Robotics Institute at Carnegie Mellon University (-2001)
  - Chief of Quality of Life Technology Center (2006-)
  - Mentor of James Kuffner

- **Dr. Pham Quang Cuong**
  - Assistant Professor at Nanyang Technological University
  - Research focus on motion planning for industrial robots
  - Mujin’s Scientific Advisor