



## MIT Mini-Cheetah Workshop

### Format

Specify the duration: Full Day

Preferred date (check one of the following):

☒ October 25, 2020 ☐ October 29, 2020 ☐ Either October 25 or October 29

### Main Organizer

Sangbae Kim (sangbae@mit.edu), Professor, Massachusetts Institute of Technology.

77 Mass. Ave. 3-455D, Cambridge, MA 02139. Tel: 1-650-996-9288

### Co-organizers

Patrick Wensing (pwensing@nd.edu), Assistant Professor, University of Notre Dame,

Inhyuk Kim (inhyeok.kim@naverlabs.com), Robotics Lead at NaverLabs.

### Sponsorship (if applicable, max. 400 words)

The workshop is sponsored by Naver Labs. One of the organizers, Inhyuk Kim is an employee at NaverLabs and the leader of their robotics division. NaverLabs has provided funding for the development of the shared robotic platform, Mini-Cheetah at the center of this workshop proposal. They also provide access to a **30 ft. by 30 ft. exhibition space at IROS that we aim to use for a robot agility course** during robot demonstrations. Following the workshop, they will sponsor the deployment of over 10 additional Mini-Cheetahs into the research community over the next year. The details of this **Mini-Cheetah Loan Program** and its application process will be communicated as part of the workshop. Potential applicants are strongly encouraged to participate in the workshop poster session to show how their work could become a part of the Mini-Cheetah community.

### Objectives (max. 600 words)

The MIT Mini-Cheetah workshop aims to address critical challenges and opportunities for legged robot **control architectures** by sharing extremely capable platforms. Through tight collaboration with MIT Mini-Cheetah teams, the workshop will compile existing legged robot controllers and collectively identify common challenges, missing tools, and architectural insights that have the broadest promise to move the field forward. The workshop will start with the introduction of a collaborative research program using the shared hardware Mini-Cheetah and open-source software for a quadruped simulator/controller. Although the contents of the workshop will be centered around controllers developed for quadrupedal robots, we believe that the topics are highly relevant for any future/current collaboration using a platform that integrates joint controllers, whole-body control, model-based optimization for predictive control, and vision-based planning. The Mini-Cheetah software is an open-source



package and can be applicable to many legged robot research programs. In addition, we aim to discuss the MIT Mini-Cheetah Loan Program to further increase the community centered around the MIT Mini-Cheetah. Application processes for the loan program will be announced at the workshop.

## Topics of interest

- Collaborative open-source robot software development
- Legged robot control architectures
  - Whole-Body Control for Quadruped Robots
  - Model-Based Optimization for Predictive Control with Simplified and Whole-Body Models
  - Learning-Based Methods
  - Architectures that combine the above to capture the unique benefits of each
- Vision integration in hardware and software
- Planning algorithms for legged locomotion in challenging environments

## Intended audience (max. 400 words)

The workshop will draw attention from researchers who want to learn about legged locomotion, hardware integration, and control algorithm implementation. We envision that the availability of the Mini-Cheetah hardware will generate wide interest from early-stage PhD students up through PIs that would aim to integrate the platform into their research labs through the Mini-Cheetah Loan Program.

## Expected attendance

We expect to have around 100 attendees in the workshop, including students from the participants' laboratories and from those laboratories that would be interested in using Mini Cheetah for their research. These numbers are based upon previous successful legged locomotion workshops appearing at ICRA and IROS in recent years.

## Invited Speakers (All confirmed)

Donghyun Kim (MIT)

Jessy Grizzle and Maani Jadidi (Michigan)

Koushil Sreenath (Berkeley)

Jerry Pratt and Robert Griffin (IHMC)

Haewon Park (KAIST)

Xingye (Dennis) Da (NVIDIA)

Jemin Hwangbo (KAIST)



## Relationship to the conference proper (max. 300 words)

The main purpose of the workshop is to discuss issues and challenges with regard to the shared hardware platform as a research tool. Research topics such as legged locomotion require a well-integrated system composed of the hardware platform and software package. We will not only discuss these individual research topics, but will also highlight cross-cutting issues related to the shared platform. This directed focus on the shared hardware platform would not be possible within the main conference program.

## Other workshops

Speaker **Jemin Hwangbo** has been invited as a speaker in the proposed workshop “Learning and Control for Perceptive Locomotion (LC4PL)”.

Speaker **Robert Griffith** is involved as a co-organizer on the proposed workshop “Fielding Legged Robots off the Beaten Path”.

Co-Organizer **Patrick Wensing** has been invited as a speaker in the proposed workshops “Learning and Control for Perceptive Locomotion (LC4PL)” and “Fielding Legged Robots off the Beaten Path,” as well as the tutorial “Review on Screw Theory & Geometric Robot Dynamics”.

## Structure of the event (max. 300 words)

The event will include a mix of technical talks, poster sessions, robot demonstrations, and a concluding panel discussion.

**Technical Talks:** All speakers will be allocated a generous 30 minute time slot, with 20 minutes for presentations and 10 minutes for discussion with the audience. Where possible, we will urge the presenters to integrate short robot demonstrations into the finale of their talk, and we anticipate that this strategy will serve as a great conversation starter.

**Poster Sessions:** We will encourage participation of PhD students by including poster teasers in the main workshop track and poster sessions during the coffee breaks. Posters will be accompanied by two-page abstracts that will be solicited in advance of the workshop using EasyChair. Abstracts will be shared on the workshop website to further help advertise the work of participants. Participation in the poster session will be taken into account for future applicants to the Mini-Cheetah Loan Program.

**Robot demonstrations:** In addition to short demos at the end of technical talks, we will include long-form demonstrations during coffee breaks (alongside the poster presentations). The sponsor of the workshop, Naver Labs, has obtained a 30 ft by 30 ft exhibitor space at IROS. We will use this space to set up a robot agility course (like a dog agility course) for all demonstrators to use. We anticipate that this space will attract a wide group of IROS participants, beyond those interested in the technical program.

**Panel Discussion:** We will include a panel discussion at the end of the event. We will include a moderator with pre-prepared questions, and will additionally solicit questions from the audience.



**Mini-Cheetah Loan Program:** At the end of the workshop, we will welcome our sponsor Naver Labs to provide details for the attendees regarding the upcoming expansion of the Mini-Cheetah Loan Program.

## Endorsement

TC on Model-Based Optimization for Robotics [Letter attached]

TC on Whole-Body Control [Letter attached]

TC on Software Engineering for Robotics and Automation [Letter attached]

## Program

Provide a (tentative) program for the workshop.

Time	Talk	Comments
9:15 – 9:30	Welcome, and opening remarks [Inhyeok Kim (Naver Labs), Sangbae Kim (MIT), Patrick Wensing (Notre Dame)]	
9:30 – 10:00	Donghyun Kim (MIT)	
10:00 – 10:30	Poster teasers	
<b>10:30 – 11:00</b>	<b>Coffee break, poster session, &amp; robot demos</b>	
11:00 – 11:30	Koushil Sreenath (Berkeley)	
11:30 – 12:00	Jerry Pratt and Robert Griffin (IHMC)	
<b>12:00 – 2:00</b>	<b>Lunch</b>	
2:00 – 2:30	Haewon Park (KAIST)	
2:30 – 3:00	Xingye (Dennis) Da (NVIDIA)	
<b>3:00 – 3:30</b>	<b>Coffee break, poster session, &amp; robot demos</b>	
3:30 – 4:00	Jemin Hwangbo (KAIST)	
4:00 – 4:30	Jessy Grizzle and Maani Jadid (U. Michigan)	
4:30 - 5:00	Panel discussion (Moderator: Sangbae Kim)	
5:00 - 5:15	Mini Cheetah Loan Program and Closing Remarks: Inhyeok Kim (Naver Labs)	

## Equipment (max. 300 words)

- **Poster Stands:** We request 10 poster stands of any standard size to support our poster session. We request that all poster stands are the same size, but do not have any specific requests beyond that.

## 2020 IEEE/RSJ

International Conference on  
Intelligent Robots and Systems(IROS)

October 25-29, 2020 Las Vegas, NV, USA



## Sponsors



Theme: Consumer Robotics and Our Future

- **Room Size:** We would also request a room with enough space in order to demonstrate the Mini Cheetahs at the front of the room after each technical talk. We plan to stream the demos to the presentation screen so that all audience members will be able to view them.
- **Microphones & AV:** We request three microphones for the panel discussion (one for the panelists, one for the moderator, and one for the audience) and any additional audio support that may be required.



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March 15<sup>th</sup>, 2020

To Whom It May Concern,

On behalf of the IEEE RAS Technical Committee on Model-Based Optimization for Robotics,  
I would like to express our support for the proposed IROS 2020 workshop:

*MIT Mini-Cheetah Workshop*

organized by Sangbae Kim, Patrick Wensing, and Inhyuk Kim.

The TC Co-Chairs have reviewed the proposal, and agree that the topics covered by the workshop are of high relevance to the TC.

The workshop is organized to target legged locomotion control architectures, where **model-based optimization plays an essential role**. In the program, four of the seven confirmed invited speakers are experts in model-based predictive control.

Furthermore, the workshop also targets the upcoming distribution of the MIT Mini-Cheetah platform to several institutes, which would give the possibility of testing and benchmark different modeling and control frameworks on the same robot. The TC considers this as a **good starting point for the community of model-based optimization to benchmark their architectures using a shared platform**.

Given the relevance of the workshop for the TC, we provide our **strong endorsement** for this workshop.

In the interest of transparency, I would like to point out that one of the co-authors of the proposal, Patrick Wensing, is also co-chair of our TC. Mr. Wensing recused himself from all discussions and decisions pertaining to this endorsement letter.

Sincerely,

Yue Hu

Co-Chair, IEEE RAS Technical Committee on Model-Based Optimization for Robotics  
JSPS fellow, CNRS-AIST JRL (Joint Robotics Laboratory) UMI3218/RL, AIST  
[hu.yue@aist.go.jp](mailto:hu.yue@aist.go.jp)

On Behalf of: Debora Clever, Adrien Escande  
Co-Chairs, IEEE RAS Technical Committee on Model-Based Optimization for Robotics



## Letter of support to the IROS 2020 workshop proposal:

### “MIT Mini-Cheetah Workshop“

This is to express our support to the “MIT Mini-Cheetah Workshop” proposed for the 2020 IEEE International Conference on Intelligent Robots and Systems (IROS) to be held on October 25 – 29, 2020 in Las Vegas, USA.

The workshop investigates open-source control architectures for legged robots developed by various collaborating teams. It aims to bring together experts in software engineering and low-level (model-predictive) control, which aligns very well within the scope of our TC. Discussions and insights provided by the workshop will be also highly relevant for the broader robotics community. Also, the MIT Mini-Cheetah capabilities will be demonstrated. Both the organizers and the invited speakers are leading researchers in this field.

As Co-Chair of the IEEE-RAS Technical Committee on Whole-Body Control, I strongly support the workshop proposal.

Kind Regards,

Dr. Niels Dehio

Co-Chair, IEEE-RAS Technical Committee on Whole-Body Control  
Laboratoire d'Informatique, de Robotique et de Microélectronique de Montpellier - LIRMM  
CNRS, France



**2020 IEEE/RSJ**

International Conference on  
Intelligent Robots and Systems(IROS)

October 25-29, 2020 Las Vegas, NV, USA



**Sponsors**



Theme: Consumer Robotics and Our Future



**Oregon State University**  
**College of Engineering**

**Robotics Program**

Oregon State University  
Corvallis, Oregon 97331-2409

March 17, 2020

To Whom It May Concern:

On behalf of the TC Software Engineering for Robotics and Automation, I would like to express our support of the proposed IROS 2020 *MIT Mini-Cheetah Workshop* organized by Sangbae Kim, Patrick Wensing, and Inhyuk Kim.

This workshop presents a unique opportunity for multiple research groups to contribute to a growing open-source software platform surrounding the Mini-Cheetah robot. Legged robots are complex systems, and that complexity often makes it way into the algorithms necessary for control. The focus of the proposed workshop on considering different control architectures and ways of collaboratively developing these architectures is of broad interest to our TC. While it would usually be a high barrier for our TC members to contribute to experimental legged robotics work, the mini-cheetah loan program could enable a much broader set of roboticists to contribute to this already highly capable platform.

Sincerely,

William Smart  
Co-Chair, IEEE RAS Technical Committee on Software Engineering for Robotics and Automation