Mintæ Kim

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RESEARCH INTERESTS

Machine Learning, Robotics, Control, Reinforcement Learning, Computer Vision, Deep Learning for Dynamical Systems, Safe and Resilient Robotic Systems, Biomimicry, Decision Making Under Uncertainty

EDUCATION

University of California, Berkeley
Aug. 2023 - Present

Ph.D. Student

- I am a Ph.D. Student in Mechanical Engineering at Hybrid Robotics Lab, University of California, Berkeley, being advised by Prof. Koushil Sreenath. Currently I am collaborating with Silicon Synapse Lab at Northeastern University and HiPer Lab at University of California, Berkeley.
- I am focusing on application of machine learning and optimization to Robot Intelligence and Dynamical Systems (RIDS). My interest spans multiple areas, including control of dynamical systems, learning-based robust motion control and planning, and biomimicry. The ultimate goal is to build systems and industries that contribute to sustainable development of mankind.

KAIST
Feb. 2019 - Feb. 2022

B.S., Individually Designed Major - Industrial and Systems Engineering, Computer Science, and Mathematics

- I was the only student in the class of 2022, graduated in three years with full scholarship.
- Course Highlights: Advanced Physics, Linear Algebra, Optimization, Stochastic Process, Data Structure and Analysis, Statistical Machine Learning, Deep Generative Model, Multi-Armed Bandit, Bayesian Optimization

Daejeon Dongsin Science High School
Mar. 2016 - Feb. 2019

- *Summa Cum Laude* (Topper in Computer Science, Mathematics, and Physics)

RESEARCH EXPERIENCE

Hybrid Robotics Lab
Aug. 2023 – Present

- Working on learning-based control of Unmanned Aerial Vehicles (UAVs) and Micro Aerial Vehicles (MAVs) at Hybrid Robotics Lab. (Major: Control / Minors: Artificial Intelligence and Fluid Dynamics)
- DiffeqML is a research group exploring the intersection of deep learning and dynamical systems at Stanford University and KAIST. I have contributed to several projects, including TorchDyn, Motion Predictive Control (MPC), and Weather Prediction. I am working on a neural gradient-based MPC simulation of quadrotor and spatio-temporal super-resolution rain prediction algorithm. I am also interested in neural differential equations (NDEs) and the physical modeling of fluids and electromagnetic fields. I want to leverage NDEs for online adaptive control of drones in complex nonlinear environments.

DiffeqML
Sep. 2022 - Present

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of drones in complex nonlinear environments.

- Model Predictive Control of Quadrotors using PyTorch
  - Contributed to tutorials for the PyTorch library for control of nonlinear dynamical system
  - Implemented *Learning to Fly-a Gym Environment with PyBullet Physics for Reinforcement Learning of Multi-agent Quadcopter Control* and simulated trajectory of a quadrotor
- TorchDyn higher-order Neural ODE variants for classification
  - Contributed to tutorials for TorchDyn, a PyTorch library dedicated to numerical deep learning
  - Showed how to easily handle higher-order neural ODEs with TorchDyn
- Super-Resolution Rain Movie Prediction under Spatio-Temporal Shifts

Ados Mar. 2022 – Nov. 2022

- I am focused on developing intelligent and robust security systems. Currently, Samsung and SK are our partners and customers for Insider Threat Prevention System and Cyber-physical Security System for Solar Cell Production and Power Plants, respectively. I utilize various machine learning techniques, including computer vision, generative modeling, statistical machine learning, and general predictive modeling for anomaly detection. We also leverage hardware, such as quadrotors and smart CCTV for our systems. Not only in research I am involved in development and distribution, which requires proficiency in C++, Java, Kubernetes, and Linux.
- Adversarial One Class Classification
- Open Set Anomaly Detection for Action Recognition (Samsung)
  - Insider Threat Prevention System with Samsung Display (Presented at ICIS 2022)
  - Developed a 3D CNN-based action recognition model for surveillance and introduced open set recognition to anomaly detection, by allowing false positives by defining every action as anomalies if is not classified as normal
  - Outperformed conventional VAD algorithms, such as supervised, generative, and predictive models
  - Pruned, quantized, and wrapped the whole Python-based model into C++ for efficiency
- LSTM Encoder-Decoder based Log Anomaly Detection (Samsung)
  - Insider Threat Prevention System with Samsung Display
- Cyber-physical Security System for Solar Cell Production and Power Plant (SK)
  - Mainly contributed to Quadrotor Surveillance System for Solar Panel Monitoring, which prevents wild animals and detects defects on panels using object detection
- Anomaly Detection for Solar Photovoltaic System based on VAE and GAN (SK)

RIMES Labs Oct. 2021 – Sep. 2023

- I co-founded RIMES Labs, an AI-based NFT generation and curation platform based in Seoul and San Francisco. Our project, RIMES Art, has been selected by the government support program and Microsoft for Startups 2022. Recently, I changed my position from CEO to CTO to focus on R&D and technological issues. With 20 developers, our team is planning to launch our service in March 2023. I have contributed to almost every decision-making, including management, marketing, business strategy, R&D, and recruiting. I am also directing RIMES Seminar, non-profit STEM education for marginalized students.
- RIMES Art: Book Illustration Generation
  - *Microsoft for Startups* program
  - Funded by South Korean government

Harp Robotics Dec. 2020 - Aug. 2021

- Harp Robotics is a research group of 7 graduate students in Mechanical Engineering and Industrial and Systems Engineering at KAIST. We are dedicated to deep reinforcement learning-based motion control and planning of drones.
- Reinforcement Learning for Adaptive Quadrotor Hovering Control
  - Developed a PPO algorithm-based control strategy that an observer estimates the forces exerted on a quadrotor, and

a controller maintains motion stability
- Trained the policy neural network of the actor to hover at the original point by receiving the state, which contains the quadrotor's shifted position, velocity, rotation, and angular velocity, and output motors thrust follows the policy
- Eliminated known disturbances, using an RL controller with a traditional observation method to achieve superior positioning performance

Miso Information Technology Dec. 2020 - Jun. 2021

- I worked on Data-Driven Traffic Management System, a government project, and figured out two tasks: Personal Information Blurring in Traffic Videos and Smart Crosswalks for Accident Prevention. I utilized a Fast Oriented Text Spotting model for scene text detection and blurring, which showed much improvement over than OCR-based model. For traffic accident prevention, I used ViTPose to monitor pedestrians by estimating their poses. I was proud to present the results at Seoul TOPIS, and my city chose our solution for Smart Crosswalks. I received the 'Best Researcher' award for the achievement.
- Smart Crosswalk for Traffic Accident Prevention by Pose Estimation
  - I used ViTPose to monitor pedestrians and prevent jaywalking by estimating poses, prior method using object detection could not prevent but just catching a person who was already jaywalking.
  - I presented the results at Seoul Transport Operation and Information Service (TOPIS), and Seoul chose our solution for Smart Crosswalks.
  - Our solution is applied to Smart Crosswalks, which are now more than 700 in Seoul.
- Scene Text Recognition for Personal Information Blurring in Traffic Video
  - Since our traffic videos were recorded in many different angle, time, and weather, OCR-based model was not sufficient. Thus, I utilized a Fast Oriented Text Spotting model for Scene Text Detection and Recognition and blurring, which showed much improvement over than previous model.
- BERT-based Sentiment Analysis and Product Recommendation System

WORK EXPERIENCE

Ados Mar. 2022 - Present

Leading Research Scientist

- Working with Samsung (Seoul, Korea) and SK (Seoul, Korea and Covington, GA, US)
- I am leading the AI security team of 6 researchers and 10 developers. We are dedicated to creating intelligent and robust cyber-physical security systems, leveraging machine learning to threat detection, such as insider threat prevention via video anomaly detection (VAD) and information leakage detection by generative modeling time series data. I have contributed to many surveillance systems against physical intrusion. Current project on Smart CCTV for construction accident detection and quadrotor observers for VAD and deep learning-based schedule and path planning are good examples of our work.

RIMES Labs Oct. 2021 - Present

Co-Founder and CTO

- There are so many talented artists in the world, but only a very few of them are famous due to the deformed structure of the art market. Supply is overflowing, but demand is minimal due to consumer need for more information. To improve this and provide fair opportunities for many artists, I co-founded RIMES Labs, a company dedicated to RIMES Art, an NFT curation, generation, and artist matching platform. With funding, including government support, I aim to make RIMES Labs an AI-based design company. I am working on text2image book illustration generation models and video summarization models.
- Selected by *Microsoft for Startups 2022* and Government funding for RIMES Art project (Acceptance rate 3.3%)
- Former CEO (Oct. 2021 – Apr. 2022)

Miso Information Technology Dec. 2020 - Jun. 2021

Research Intern at Machine Learning Team

- I received an internship opportunity at Miso Information Technology during my sophomore year. All my academic background in CS, Math, Industrial, and Systems Engineering collectively fit perfectly well with three research projects I contributed for seven months. Another great experience was the weekly seminar on ML, where I could learn technical aspects of machine learning, which I only knew in theory with little practice. I could grow fast through preparing for my presentations about gradient descent, object detection, and scene text recognition focusing on mathematical reasoning of models.
- *Best Researcher Award 2022*

D&B Edu Consulting Aug. 2019 - Jun. 2022

Co-Founder and CEO

- D&B Edu Consulting is a non-profit education consulting group for students in marginalized groups. I co-founded and headed the group as a CEO until June 2022. We mainly worked on educational materials for mathematics, physics, computer science, biology, and chemistry at the level of SAT. We held several seminars on mathematics, and I directed most of them. I also opened mathematics and informatics olympiad classes for creative and outstanding students. Since I was in the same position in poor circumstances when I was a teenager, I am proud that I could help my students discover their dreams.
- Front-end and Back-end Developer

Seoul Basketball Academy Mar. 2019 - Dec. 2020

Assistant Coach

- Co-Director of Korea U16 National Team Training Camp

PAPERS & PUBLICATIONS

Open Set Action Anomaly Detection Oct. 2022
Mintae Kim[1], Hyeongmin Moon[2]
KSII Transactions on Internet and Information Systems (Under Review)

Insider Threat Prevention System through Video and Log Anomaly Detection Jun. 2022
Mintae Kim[1], Hyeongmin Moon[2], Jake Lee[2]
Research Project with Samsung Display Security Department

Regression Approach for Learning Linear Time-Invariant Dynamic Models Oct. 2021
Mintae Kim[1]
Undergraduate Thesis Paper

Network Intrusion Detection based on Hierarchical AutoEncoder Oct. 2020
Mintae Kim[1], Hyeonseung Choi[1]
Undergraduate Research Paper at KAIST and Yonsei University (Written in Korean)

BOOK CHAPTERS & WRITINGS

Can Computers Really Understand Humans and Natural Language? Sep. 2022
Mintae Kim
Naeil News, Science and Technology Section (Written in Korean)

Multiple Slit Diffraction and X-Ray Diffraction Feb. 2020
Mintae Kim, Heeju Na

General Physics Experiments for Freshmen, KAIST Press

Euler-Lagrange Equation and its Applications Nov. 2019
Mintae Kim, Seokmin Yoon
Advanced Physics, Daejeon Dongsin Science Highschool

Nonlinear Oscillations and Chaos Sep. 2019
Mintae Kim, Seokmin Yoon
Advanced Physics, Daejeon Dongsin Science Highschool

RESEARCH PROJECTS

Deep Learning for Differential Equations and Dynamical Systems Sep. 2022 - Present
Michael Poli, Stephano Massaroli, Mintae Kim
Research Project at DiffeqML

Efficient Crime Surveillance System via Open Set Recognition Sep. 2022 - Present
Mintae Kim, Gaeun Lee, Joonyong Choi
Research Project at RIMES Labs and Ados

FoodGAN: Food Image Generation using Deep Convolutional GAN Dec. 2021
Mintae Kim
Final research project for Deep Generative Model, Multi Armed Bandit, and Bayesian Optimization class at KAIST

BERT-based Recommendation System using Data from Social Network Services Dec. 2020
Mintae Kim, Minjae So
Research Project at Miso Information Technology

Stable Networks of Coupled Nonlinear Oscillators Feb. 2020
Mintae Kim[1], Heeju Na[2]
Research project paper for Electromagnetics and Quantum Mechanics class at KAIST

Modern review on classical electromagnetics: Aharonov-Bohm Effect in Electron-Electron Interactions and Momentum Conservation Paradox Dec. 2019
Mintae Kim[1], Heeju Na[2]
Research project paper for Electromagnetics and Quantum Mechanics class at KAIST

Energy Conservation Mechanism of Acoustic Wave Interference in Electronic Devices Nov. 2019
Mintae Kim[1], Heeju Na[2]
Research project paper for Electromagnetics and Quantum Mechanics class at KAIST

Generalized Brachistochrone Problem with Snell's Theory Jun. 2019
Mintae Kim[1], Heeju Na[2]
Research project paper for Mechanics and Thermodynamics class at KAIST

Why Doors Always Stop: Bernoulli's Equation in a Single-Door System and Analysis Apr. 2019
Mintae Kim[1], Heeju Na[2]
Research project paper for Mechanics and Thermodynamics class at KAIST

CEOSAT: Chemical Explosion Observing Satellite Jul. 2018
Mintae Kim, Dongsoo Choi, Yunjee Hong

KAIST Satellite Technology Research Lab Cube Satellite Contest (Won First Place)

Micro Carbon Nanotube X-ray Emitter for Medical Imaging Jan. 2018
Mintae Kim, Sungoh Cho
Research project at KAIST Quantum Beam Engineering Lab

INVITED AND CONTRIBUTED TALKS

Korea Quantum Computing Corporate Association Jun. 2022
- Colloquium at Korea Institute of Science and Technology Information
- Title: *Introduction to Quantum Machine Learning*

KSCY Jan. 2021
- Seminar at Mechanical Engineering and Electrical Engineering Sessions
- Title: *How to Adopt Deep Learning in Your Robotics Research*

SERA Apr. 2020
- Quarterly Seminar at Yonsei University
- Title: *Tutorial: DJI Tello Edu Drone and Object Detection*

Daejeon Dongsin Science High School Mar. 2020
- Computer Science Seminar for Freshmen
- Title: *Object Detection and Action Recognition with OpenCV*

SERA Dec. 2019
- Quarterly Seminar at Yonsei University
- Title: *What is Between Newton's Cradle and Schrodinger's Equation?*

TEACHING

Primestone Consulting Mar. 2021 - Dec. 2021
- Computer Science and Mathematics for IMO and IOI
- AP Computer Science and Mathematics for ages 16-18

D&B Edu Consulting Aug. 2019 - Jun. 2021
- Computer Science and Mathematics for IMO and IOI
- Calculus, Differential Equations, Mathematical Statistics and Linear Algebra
- AP Computer Science and Mathematics for ages 16-18
- Wrote *Mark's Essential AP Calculus BC with Problems*

Korean Mathematical Olympiad Dec. 2019 - Feb. 2020
- Teaching Assistant at Korean Mathematical Olympiad Winter School

VOLUNTEER EXPERIENCE

RIMES Seminar Mar. 2022 - Present
- *Exploring Deep Generative Model: Generative Adversarial Networks* (Sep. 2022)
- *Exploring Deep Generative Model: Normalizing Flows* (Aug. 2022)
- *Exploring Deep Generative Model: Variational AutoEncoder* (Jul. 2022)
- *Deep Dive into Neural Process* (Jun. 2022)
- *Deep Dive into Gradient Methods* (May. 2022)
- *Deep Dive into Neural Networks* (Apr. 2022)

KSCY Sep. 2019 - Sep. 2021

- *Introduction to Differential Geometry and Topology* Lecture at Winter Camp 2021
- *PDE101: What Are They Partial Differential Equations* Lecture at Summer Camp 2021
- *Maxwell's Equations and PDEs* Lecture at Mathematics Session 2020
- *Introduction to Motion Planning* Lecture at Mechanical Engineering Session 2019

YuCheon Community Child Care Center Feb. 2020 - Jan. 2021

- Drone and Arduino Classes for ages 14-16 with SERA
- Taught Mathematics for ages 14-16 with SERA
- Basketball Team Coach

SKILLS & OTHERS

Programming Skills

- Python, Matlab, Java, C++
- PyTorch, Tensorflow, Keras
- Linux, Kubernetes
- Javascript, HTML, CSS, React

Others

- Coursera - *Modern Robotics: Mechanics, Planning, and Control Specialization* (Northwestern University)
- Coursera - *Robotics: Aerial Robotics* (University of Pennsylvania)
- Inaugural Member of Korea Quantum Computing Corporate Association
- Assistant Coach at KAIST Basketball Team Dooley