Isin Mert **Balci**

PhD Student in Aerospace Engineering

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Summary

Ph.D. student in Aerospace Engineering with a special focus on Control Theory, Autonomous Systems, and Robotics. Exploring the theory and applications of stochastic optimal control and reinforcement learning for uncertain, safety-critical systems. Eager to expand the knowledge on stochastic controls, motion planning, and probabilistic trajectory optimization into real-world problems where randomness is ubiquitous and safety is utterly important.

Education

Bogazici University
BS in Mechanical Engineering

Istanbul, Turkey
Sep. 2013 - Jun. 2018

- Graduated with First Class Honours
- GPA: 3.89/4.0

Georgia Institute of Technology
BS in Mechanical Engineering

Atlanta, GA
Aug. 2016 - Dec. 2016

- Reciprocal Exchange Student
- GPA: 4.0/4.0

University of Texas at Austin
MS/PhD in Aerospace Engineering in Controls, Autonomy and Robotics Track

Austin, TX
Aug. 2018 - Current

- Advisor: Assoc. Prof. Efstathios Bakolas
- GPA: 3.88/4.0, Expected Graduation Date: May 2023
- Selected Coursework: Convex Optimization, Stochastic Processes, Optimal Control Theory, Statistical Estimation Theory, Statistical Machine Learning

Skills

Programming	Python (Advanced), MATLAB (Advanced), C (Beginner), Julia (Beginner)
Mathematical	Mathematical Optimization, Optimal Control, Stochastic Control, Trajectory Optimization, Reinforcement Learning
Language	Turkish (Native), English

Research Projects

Optimal Trajectory Generation using Differential Dynamic Programming Algorithm
Undergraduate Researcher

Atlanta, GA
(Completed) Dec. 2016

- DDP algorithm is learned and applied to inverted pendulum problem
- Open loop optimal control sequence is generated using different cost functions

Gaussian Processes for Safe Imitation Learning
Graduate Research Assistant

Austin, TX
(Completed) Aug. 2019

- Trained GPs for inverted pendulum task in OpenAI-gym environment
- Multiple GPs are combined to get a better result with MCMC algorithm
- A reversible jump MCMC algorithm is implemented for policy inference

Robust Trajectory Optimization with Covariance Steering and MPPI
Graduate Research Assistant

Austin, TX
May 2021 - Ongoing

- A stochastic trajectory optimization architecture is presented based on Covariance Steering and Model Predictive Path Integrals to achieve robustness
- Proposed approach is tested in various challenging stochastic optimal control problems that focus safety aspect
- Results have been submitted to be published in ACC 2022.

Covariance Control of Linear Systems with Soft Terminal Constraints
Graduate Research Assistant

Austin, TX
May 2020 - Ongoing

- Formulated the covariance steering with wasserstein terminal cost problem as a difference of convex program
- Solved the DCP using convex-concave procedure, compared results with general purpose nonlinear programming solvers
- Results have been published in ACC 2021 and CDC 2021

Publications and Preprints

Journal

1. I. M. Balci and E. Bakolas, "Covariance Steering of Discrete-Time Stochastic Linear Systems Based on Wasserstein Distance Terminal Cost," in IEEE Control Systems Letters, doi: 10.1109/LCSYS.2020.3047132.

Conference

1. I.M. Balci, E. Bakolas, "Covariance Control of Discrete-Time Gaussian Linear Systems Using Affine Disturbance Feedback Control Policies" accepted to appear in CDC 2021

2. I.M. Balci, E. Bakolas, A. Halder, "On the Convexity of Discrete Time Covariance Steering in Stochastic Linear Systems with Wasserstein Terminal Cost" accepted to appear in CDC 2021

Preprints

1. I.M. Balci, E. Bakolas, "Covariance Steering of Discrete-Time Stochastic Linear Systems Based on Distribution Distance Terminal Costs"

2. I.M. Balci, E. Bakolas, B. Vlahov, E. Theodorou, "Constrained Covariance Steering based tube-MPPI" submitted for publication in ACC 2022

Work Experience

Baykar Technologies
Istanbul, Turkey

Engineering Intern in R&D Department
Jan. 2017 - Aug. 2017

- Obtained mathematical models for turboprop jet engines
- Dynamic simulations are performed for turboprop jet engine on Simulink
- Conducted Performance Simulations of UAVs using MATLAB and Simulink

UT Austin
Austin, TX

Graduate Research Assistant
Aug. 2018 - Current

- Formulating reseach problems using the tools from dynamical systems and control theory
- Developing solution methods for the problems using mathematical optimization and machine learning
- Publishing research results in international journals and conferences
- Guiding undergraduate researchers

Course Projects

Aircraft Pitch Control
Istanbul, Turkey

ME 43A: Application of Control Systems
Nov, 2017

- Mathematical models are obtained using flight dynamics equations
- Design specifications are determined and a lead/lag compensator is designed to control the pitch angle
- Validity of controller is verified with extensive simulations on MATLAB

Safe Reinforcement Learning via Shield Synthesis
Austin, TX

ASE 396: Design and Verification of Cyber-Physical Systems
Dec, 2018

- Shield for preventing unsafe actions with respect to LTL safety specification is generated
- Together with the environment abstraction, shield is synthesized for a gridworld agent
- Complete algorithm is tested on a gridworld environment with the Q-learning algorithm

Event-Triggered Control for Stabilization of Rotary Inverted Pendulum
Austin, TX

ASE 396: Networked Control Systems
April, 2019

- Triggering Rule based on linearized dynamics are obtained
- Event-triggered control law is tested on both simulations and real-time experiments
- Communication between controller and sensors are reduced by up to 30% in real-time experiments