CPS: Medium: Correct-by-Construction Controller Synthesis using Gaussian Process Transfer Learning
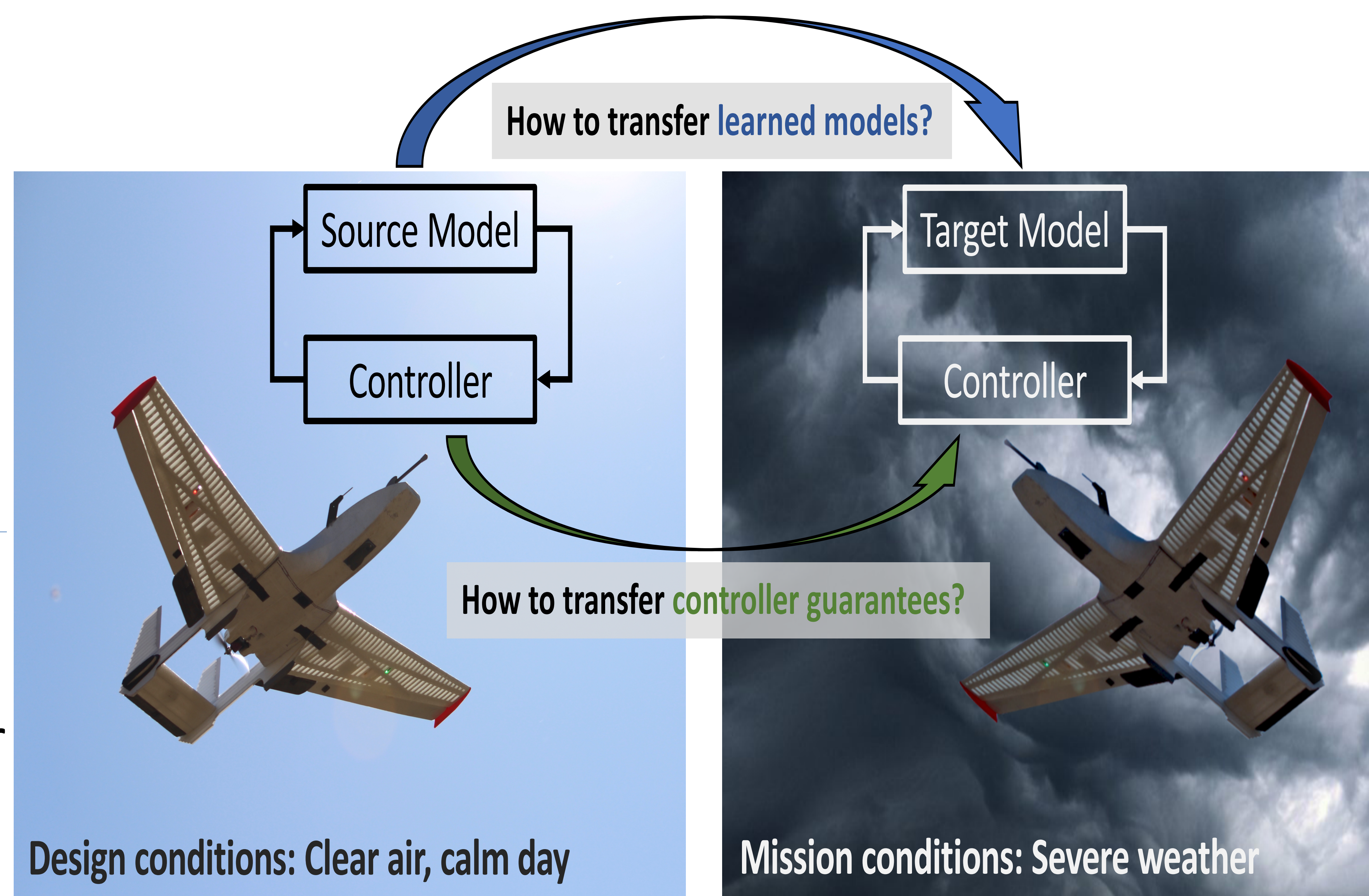
(Award #: 2039062, Date: 01/01/2021-12/31/2023, PI: Majid Zamani, Co-PIs: Eric Frew & Morteza Lahijanian)

Challenge:

- Correct-by-construction design of controllers for complex CPS with black-box models by embracing ideas from control theory, formal verification, and Gaussian processes

Solution:

- Formal controller synthesis for unknown CPS through GP regression and constructing barrier certificates.
- Transfer learning and exploration planning.
- Formal analysis and synthesis for GP transfer learning.

How to transfer learned models?

Source Model → Controller

Target Model → Controller

How to transfer controller guarantees?

Design conditions: Clear air, calm day

Mission conditions: Severe weather

The goal of this project is to develop a framework for correct-by-construction control synthesis for CPS with unknown models by exploiting Gaussian process transfer learning to transfer formal guarantees.

Scientific Impact:

- Introducing new methodologies, algorithms, and tools for safe and autonomous deployment of CPS by developing data-driven, correct-by-construction design of embedded control software for them.

Broader Impact:

- Broaden participation of women in graduate computer science and aerospace engineering programs (MS and PhD) through a series of activities focused on undergraduate women at CU Boulder.
- Incorporating the performed research tasks into the courses taught by the PIs.