ETH zürich

Estimation of Actuation Configuration for a Multi-Actuated Blimp

Semester Thesis

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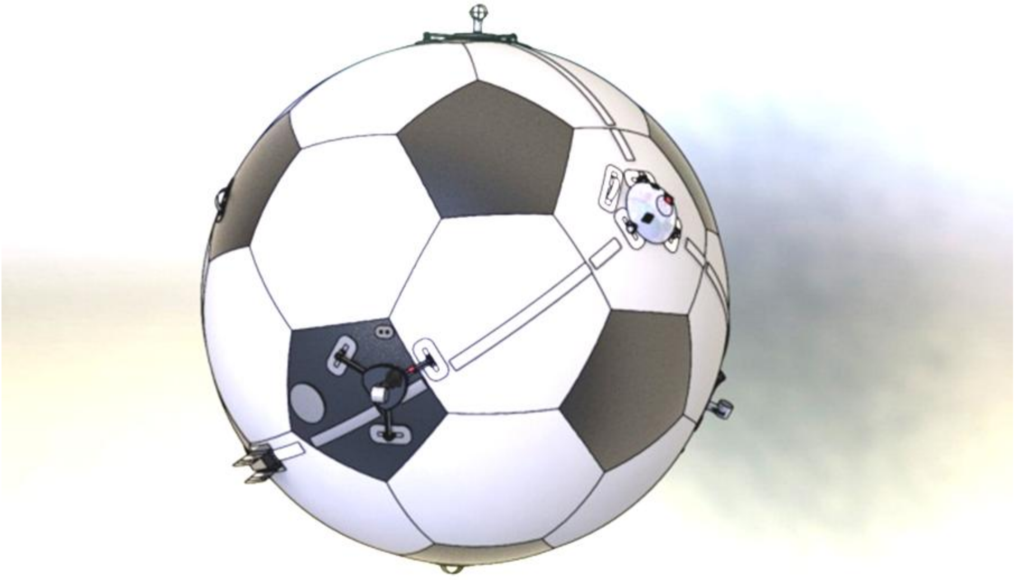
Autonomous Systems Lab

Overview

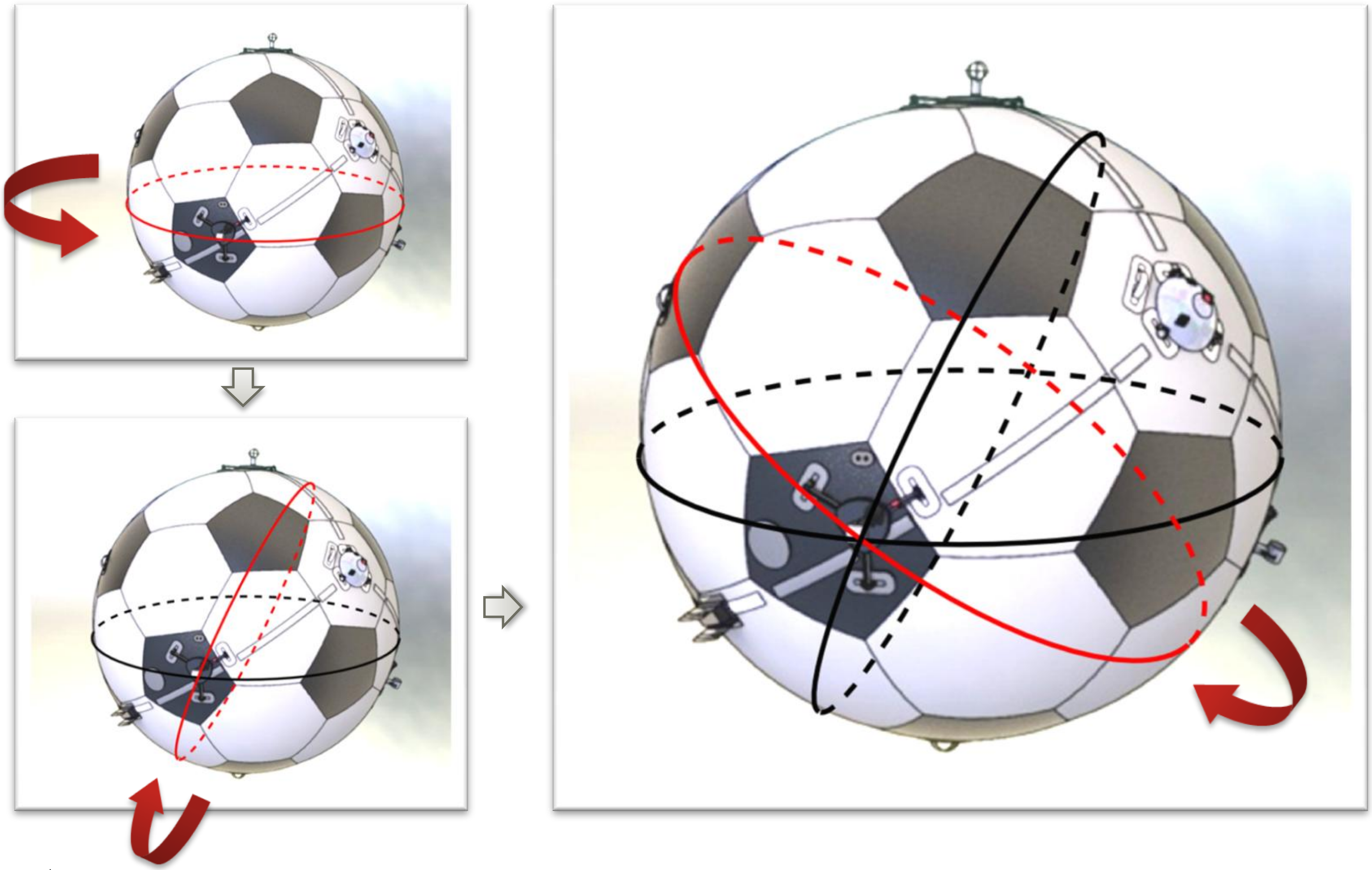


Problem: Motor to Blimp transformation is essential part of controller

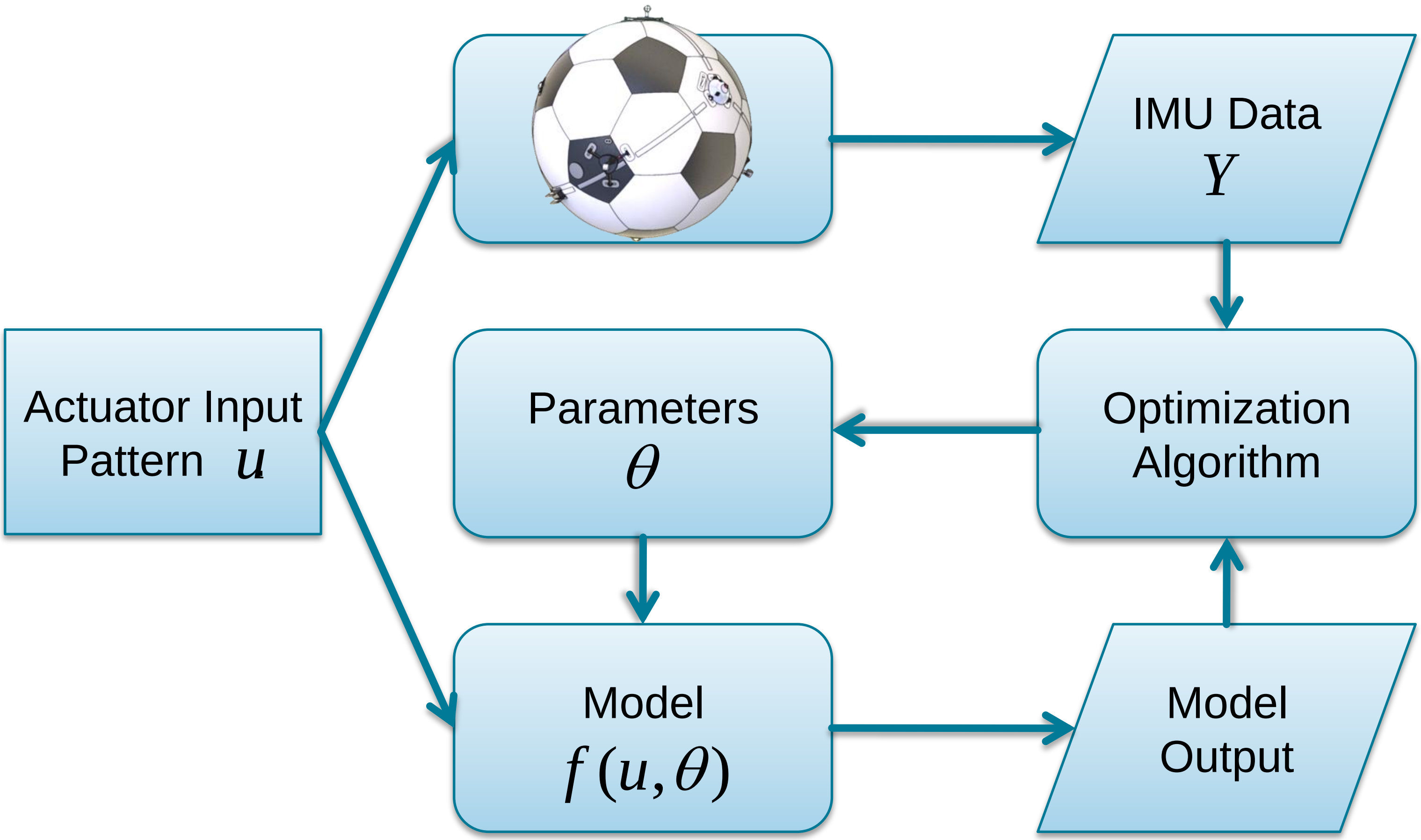
Idea: Create blimp model from Motor transformations and fit this model to the system

How: Actuate blimp and compare measurements with model output

Concept



Batch Optimization Process



Model Function

$$\vec{\alpha} = J^{-1}(r\, C(\theta)\, \vec{u} - \vec{\omega} \times J\vec{\omega})$$

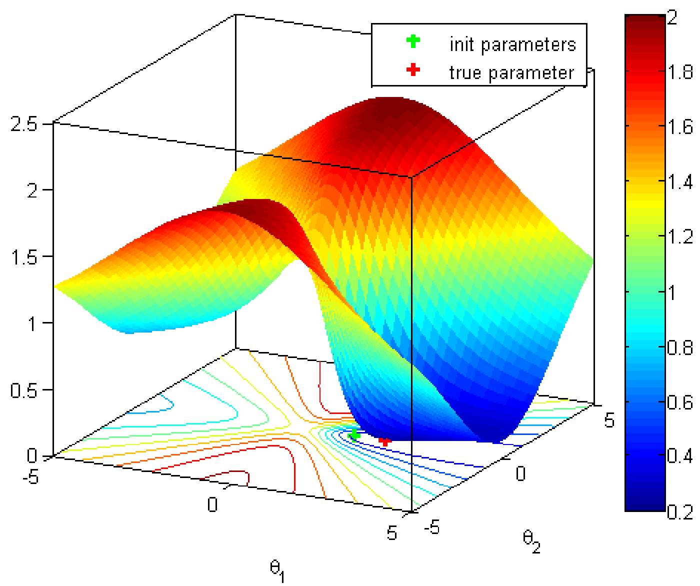
$C(\theta)$	Thrust force transformation
$\vec{u}$	Thrust force (input)
$\vec{\omega}$	Angular velocity
$\vec{\alpha}$	Angular acceleration
r	Radius
J	Inertia tensor

Parameterization

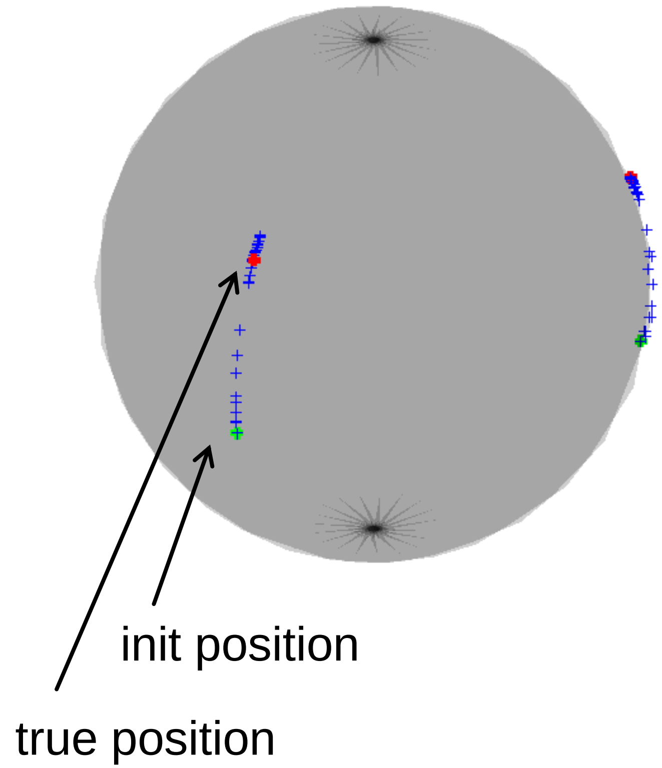
Gibbs-Rodriguez (3)
Quaternionen (4)

Current Results

- Gibbs-Rodriguez Parameters

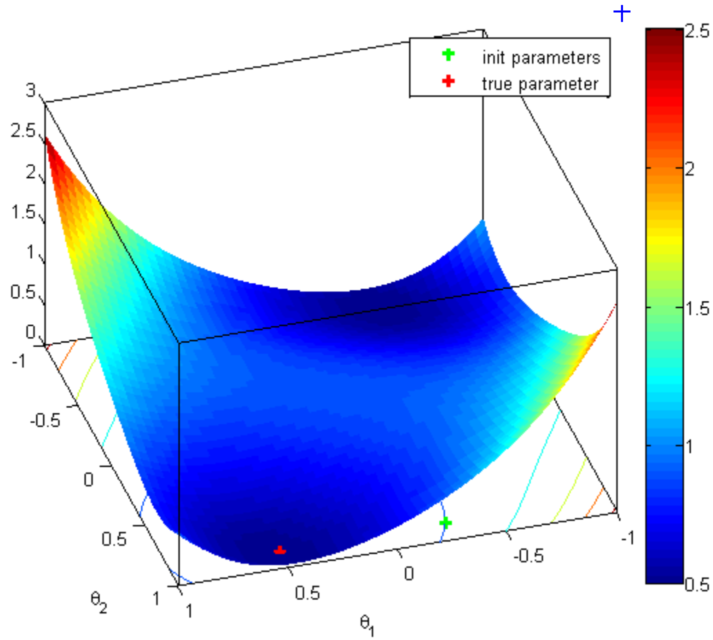


Residual plot in parameter space

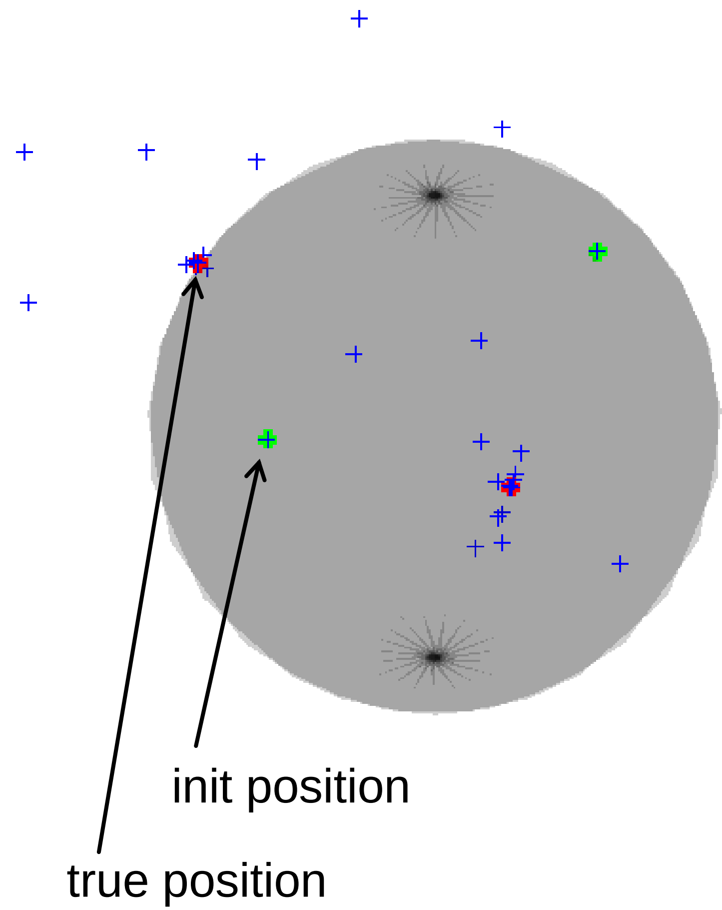


Current Results

- Quaternion Parameters



Residual plot in parameter space



Outlook

- Parameterization for radius, inertia tensor
- Actuator input patterns
- Varied simulation data from modular simulation model
- Convergence analysis

Context / General Description

- Control depends on simplified model of blimp
  - Fit paramteres of simplified model s.t. it best fits real system

Problem Formulation

- Nonlinear Least Squares Optimization
  - $S(\theta) = \sum_{u=1}^{n} \{Y_u - f(\xi_u, \theta)\}^2$

  Y_u : Angular acceleration from gyro measurement
  $f(\xi_u, \theta)$: Nonlinear function depending on inputs ξ_u and parameters θ

- Parametrization

Quaternion

No Singularities

Constrained $\|q\| = 1$

Quadratic model

$$q = \begin{bmatrix} \cos(\varphi/2) \\ n \cdot \sin(\varphi/2) \end{bmatrix}$$

Gibbs-Rodriguez

Singularity at $\varphi = \pi/2$

Unconstrained

Nonlinear model

$$\lambda = n \cdot \tan(\varphi/2)$$

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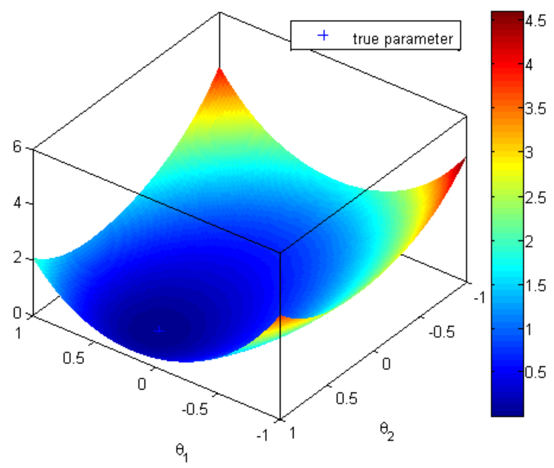

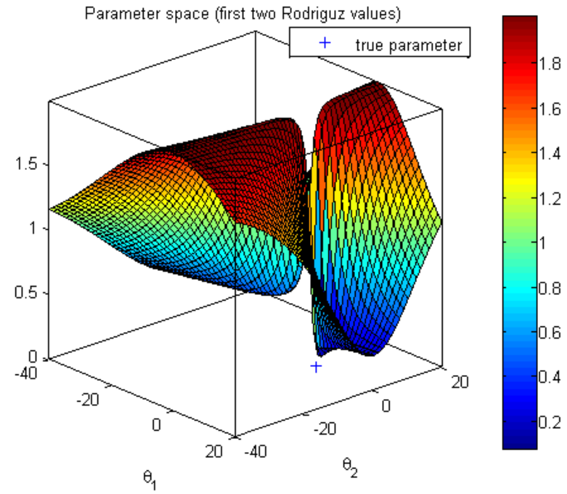

Example

- Video?

Outlook

- Inputs bla bla …
- Text Cases …
- Estimate Accuracy of Result ...