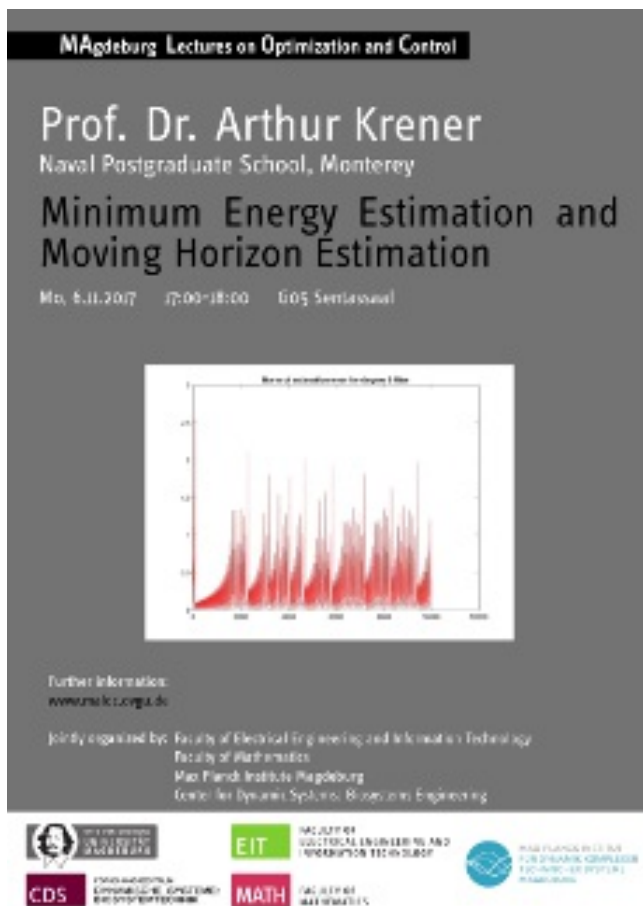


## MAGDEBURG LECTURES ON OPTIMIZATION AND CONTROL

### Arthur Krener



MAGdeburg Lectures on Optimization and Control

Prof. Dr. Arthur Krener  
Naval Postgraduate School, Monterey

Minimum Energy Estimation and  
Moving Horizon Estimation

Mo, 6.11.2017 17:00-18:00 G05 Senatssaal

Further information:  
[www.mik.uni.gwdg.de](http://www.mik.uni.gwdg.de)

Jointly organized by: Faculty of Electrical Engineering and Information Technology  
Faculty of Mathematics  
Max-Planck-Institut Magdeburg  
Control, Dynamics, Systems, Robotics, Engineering

CDS EIT MATH

### 27.10.2017 - Minimum Energy Estimation and Moving Horizon Estimation

› Prof. Dr. Arthur Krener

([https://www.math.ucdavis.edu/research/profiles/?fac\\_id=krener](https://www.math.ucdavis.edu/research/profiles/?fac_id=krener))

Naval Postgraduate School, Monterey

#### Time & Place

The presentation on November 6, 2017 will be given in the Senatssaal (G05) and starts at 5.00 p.m..

#### Abstract

Minimum Energy Estimation is a way of filtering the state of a nonlinear system from partial and inexact measurements. It is a generalization of Gauss' method of least squares. Its application to filtering of control systems goes back at least to Mortenson who called it Maximum Likelyhood Estimation \cite{Mo68}. For linear, Gaussian systems it reduces to maximum likelihood estimation (aka Kalman Filtering) but this is not

true for nonlinear systems. We prefer the name Minimum Energy Estimation (MEE) that was introduced by Hijab \cite{Hi80}. Both Mortenson and Hijab dealt with systems in continuous time, we extend their methods to discrete time systems and show how power series techniques can lessen the computational burden.

Moving Horizon Estimation (MHE) is a moving window version of MEE. It computes the solution to an optimal control problem over a past moving window that is constrained by the actual observations on the window. The optimal state trajectory at the end of the window is the MEE estimate at this time. The cost in the optimal control problem is usually taken to be an L2 norm of the three slack variables; the initial condition noise, the driving noise and the measurement noise. MHE requires the buffering of the measurements over the past window. The optimal control problem is solved in real time by a nonlinear program solver but it becomes more difficult as the length of the window is increased.

The power series approach to MME can be applied to MHE and this permits the choice of a very short past window consisting of one time step. This speeds up MHE and allows its real time implementation on faster processes. We demonstrate its effectiveness on the chaotic Lorenz attractor.

