Research on Theory and Application of Intelligent Optimization based Control System

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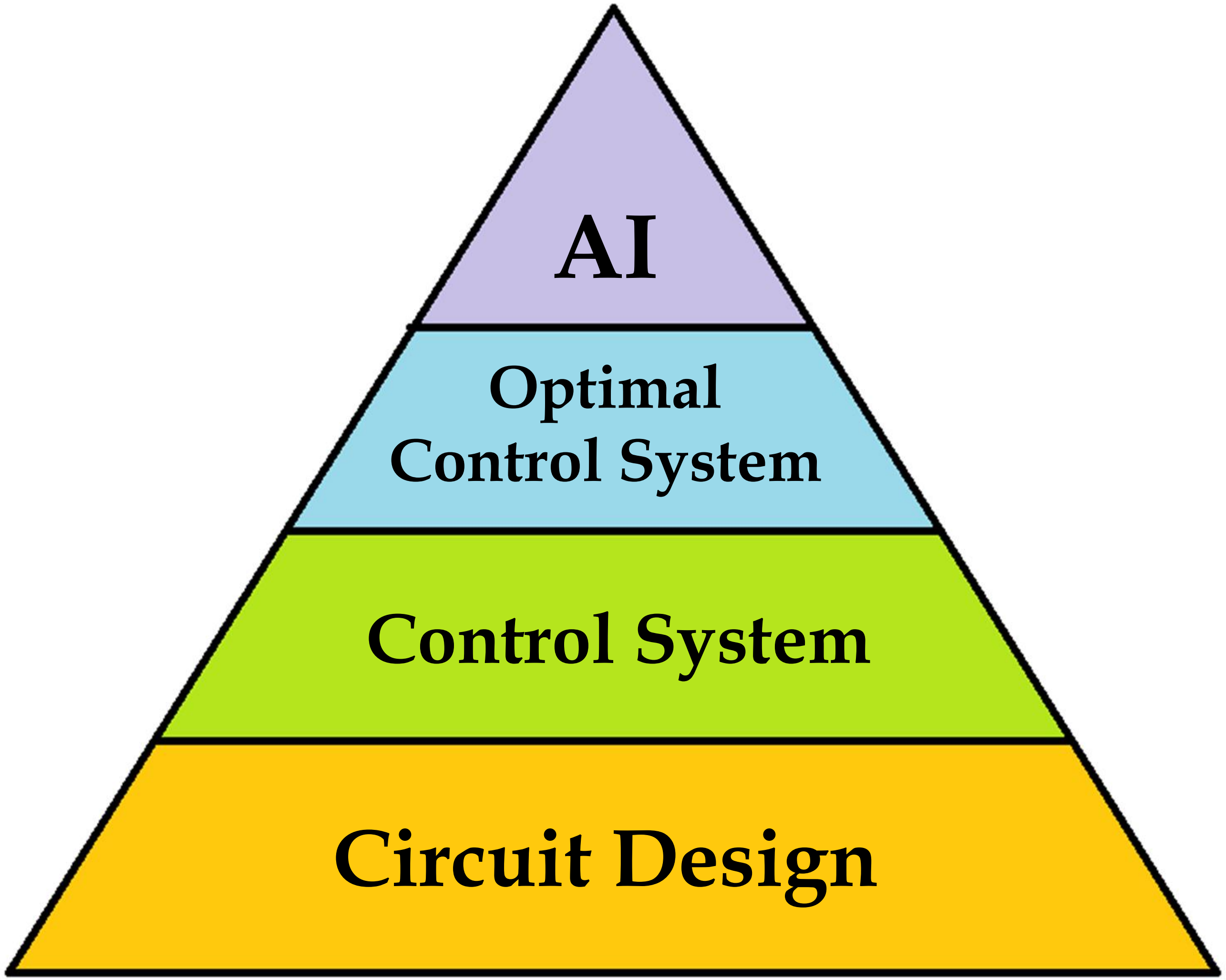
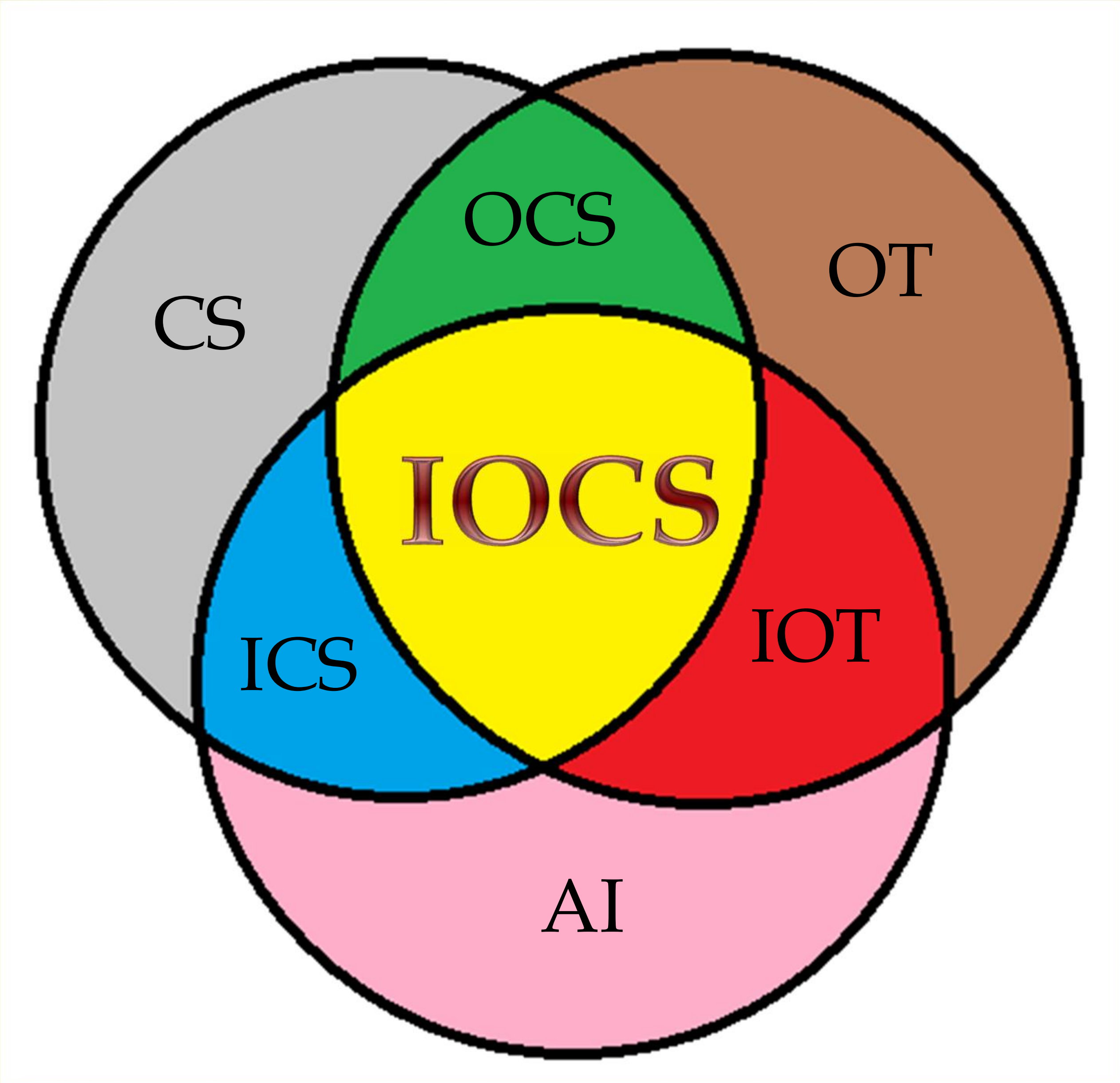

AI
Optimal
Control System
Control System
Circuit Design



CS : Control System
OT : Optimization Theory
AI : Artificial Intelligence
OCS : Optimal Control System
IOT : Intelligence Optimization Theory
ICS : Intelligence Control System
IOCS : Intelligence Optimal Control System

PLANT

Motor DC/AC
Ultrasonic motor
Gantry crane system
Inverted pendulum
Tank level system
Heater and oven system
Hydroponic system
Green house system
Unicycle system
Balancing robot
Quad copter
Inverter and converter

MODELING

Physical analysis
Experimental
Parameter estimation
AI untuk modeling
Linear system
Nonlinear system
Low order system
High order system
Time delay system
Stable system
Unstable system
Linearization → simplification
TF or SS

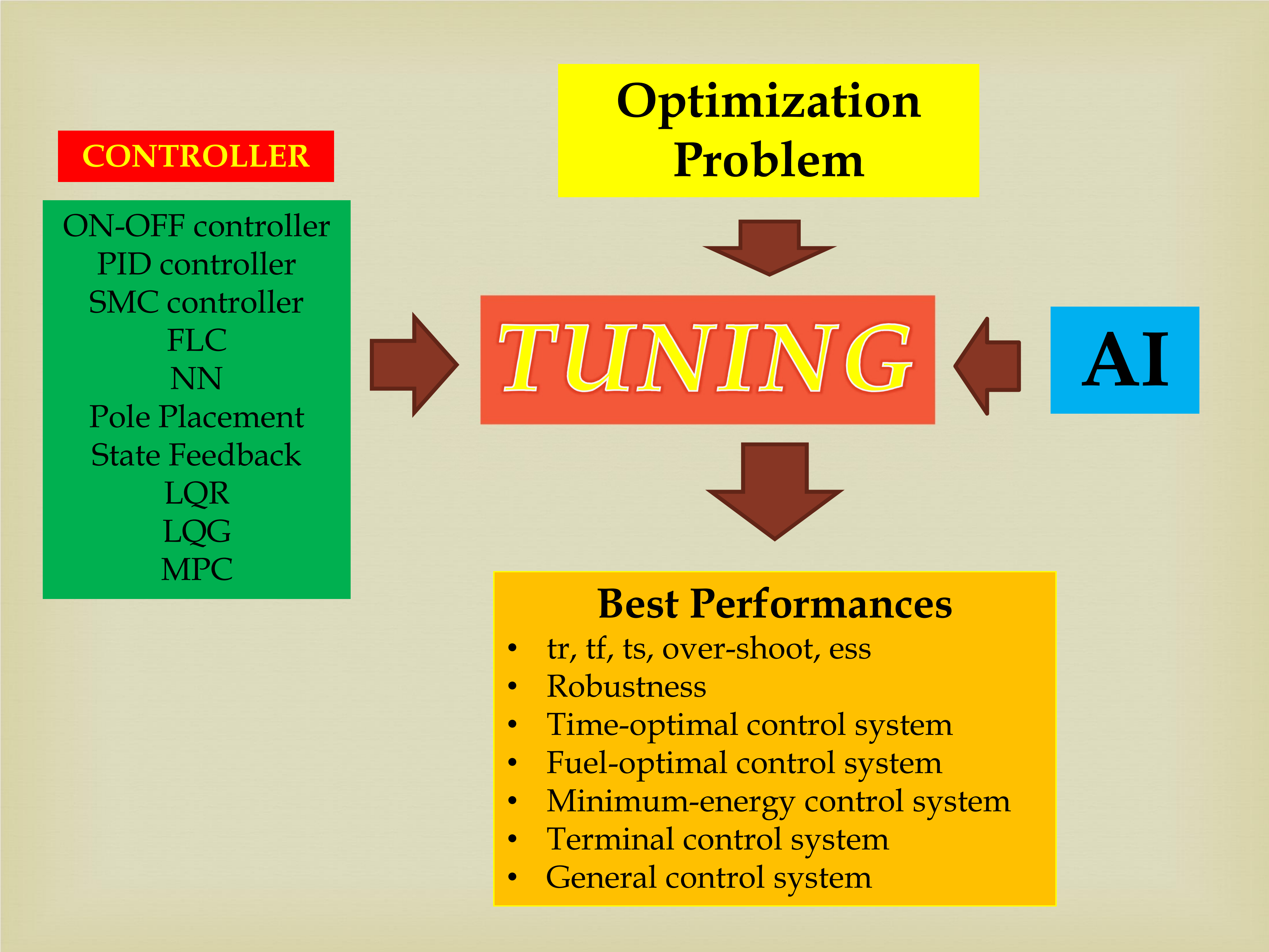
CONTROLLER

Open loop controller
Closed loop controller
Model-based controller
Free model-based controller
Linear/Nonlinear controller
Intelligence controller
Optimal controller
Adaptive controller
Hybrid controller

PERFORMANCES

Rise-time
Fall-time
Settling-time
Over-shoot
Error steady-state
Robustness
Tracking
Energy

CONTROL SYSTEM


CONTROLLER
ON-OFF controller
PID controller
SMC controller
FLC
NN
Pole Placement
State Feedback
LQR
LQG
MPC
Optimization Problem
TUNING
AI
Best Performances
• tr, tf, ts, over-shoot, ess
• Robustness
• Time-optimal control system
• Fuel-optimal control system
• Minimum-energy control system
• Terminal control system
• General control system

Intelligent
Optimal Control System

Mata kuliah yang membahas disain sistem kontrol yang bertujuan mengoptimalkan performansi (***minimum time-criteria*** dan ***minimum energy***) menggunakan metode tuning berbasis kecerdasan buatan

LQR (Linear Quadratic Regulator)
LQG (Linear Quadratic Gaussian)

Kontrol Non-Optimal vs. Kontrol Optimal

PID Controller

Performansi (tr, ts, tf, overshoot, ess) sebaik mungkin dengan energi berapapun juga (energi tidak dibatasi atau bukan batasan)

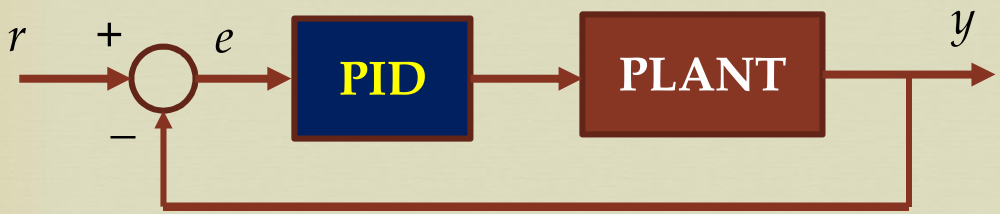
Optimasi tanpa pembatas
(unconstrained optimization)

LQR/LQG

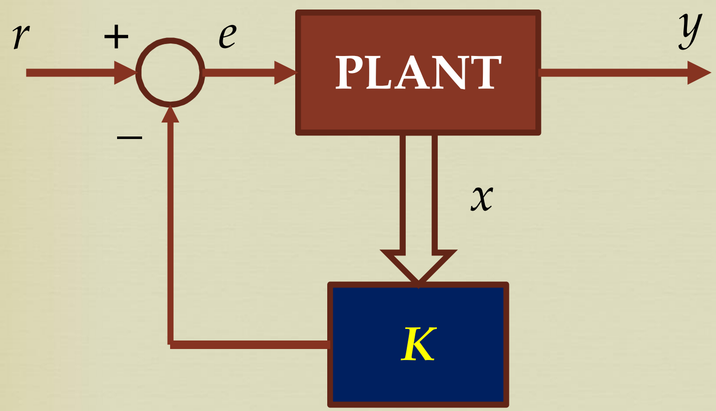
Performansi (tr, ts, tf, overshoot, ess) sebaik mungkin dengan batasan energi (energi sebagai batasan)

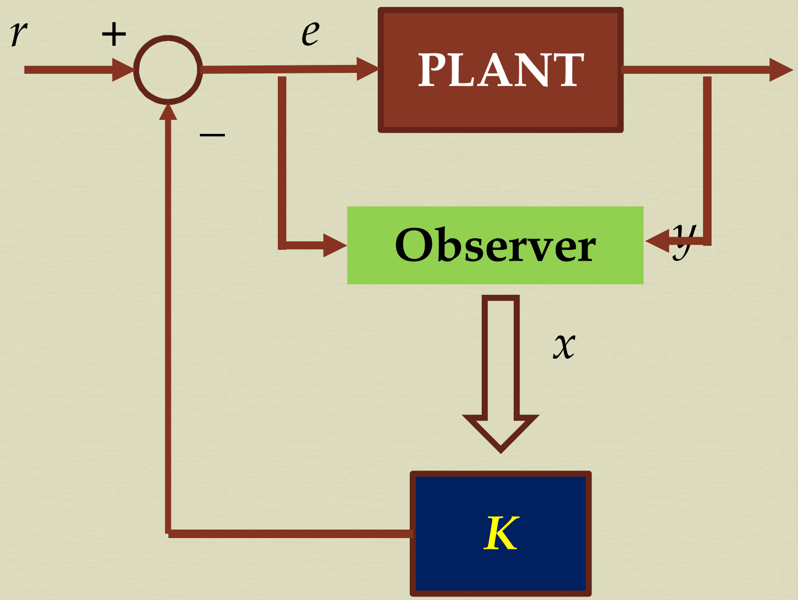
Optimasi dengan pembatas
(constrained optimization)

LEBIH SULIT

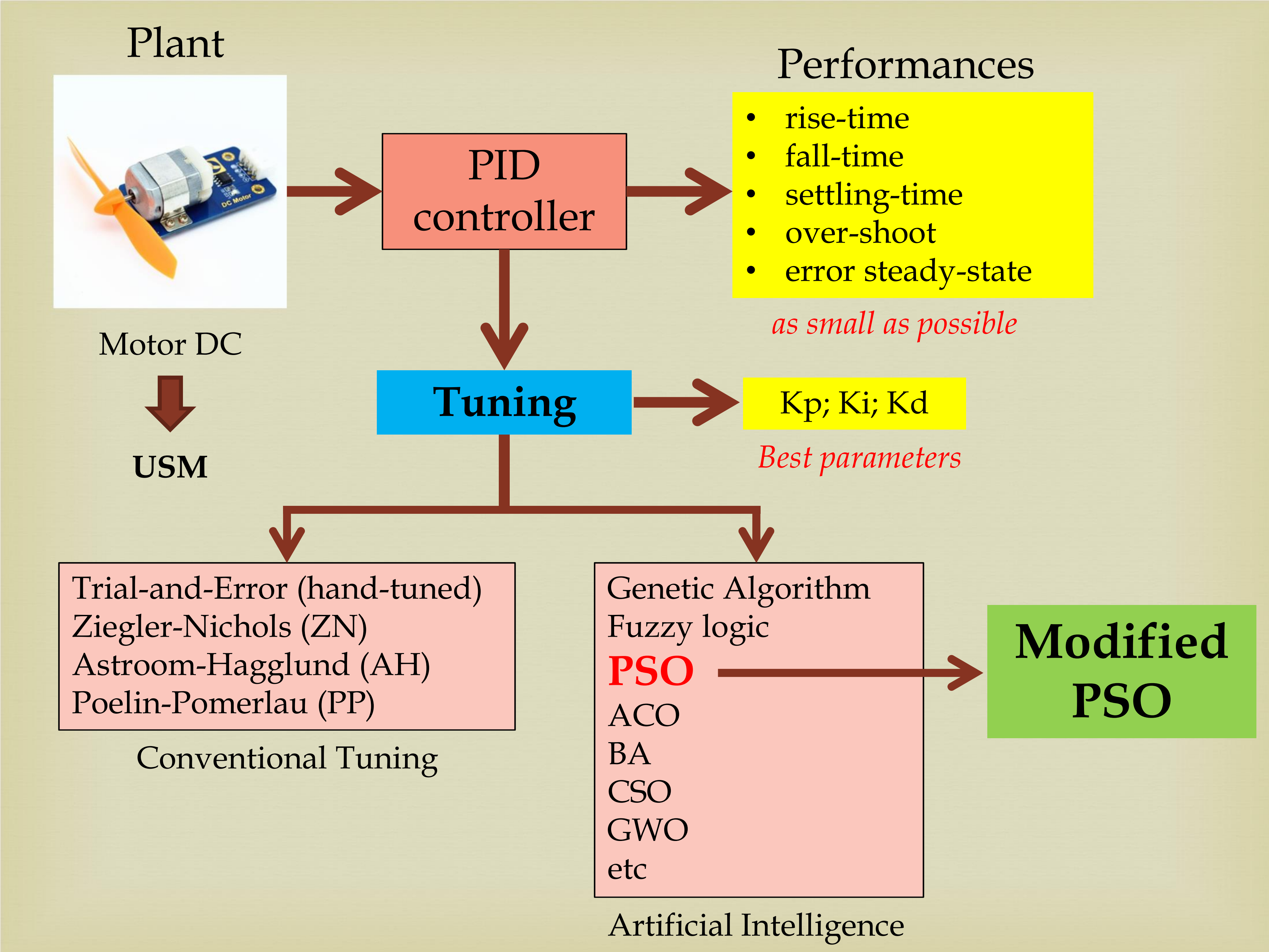


Kontrol PID





LQR/LQG

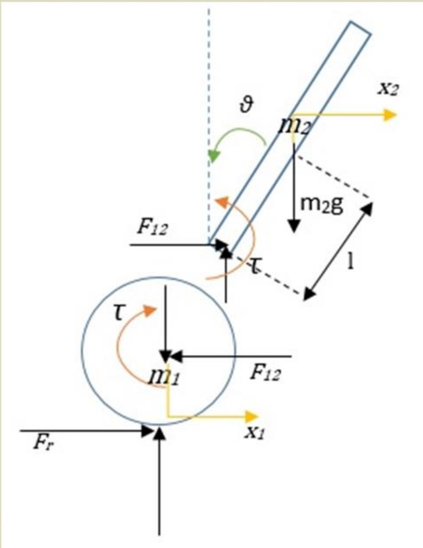

Plant
DC Motor
Motor DC
USM
PID controller
Performances
rise-time
fall-time
settling-time
over-shoot
error steady-state
as small as possible
Tuning
Kp; Ki; Kd
Best parameters
Trial-and-Error (hand-tuned)
Ziegler-Nichols (ZN)
Astroom-Hagglund (AH)
Poelin-Pomerlau (PP)
Conventional Tuning
Genetic Algorithm
Fuzzy logic
PSO
ACO
BA
CSO
GWO
etc
Artificial Intelligence
Modified PSO

Robot Balancing – modeling and control

Mod-PSO

PID Controller

LQR/LQG



State-Space Representation and Transfer Function

$$A=\begin{bmatrix}0 & 1 & 0 & 0\\ 0 & -8.4467 & 76.1749 & 0\\ 0 & 0 & 0 & 1\\ 0 & -43.8205 & 709.2218 & 0\end{bmatrix}, B=\begin{bmatrix}0\\ 1.6244\\ 0\\ 8.4270\end{bmatrix}$$

$$C=\begin{bmatrix}1 & 0 & 0 & 0\\ 0 & 0 & 1 & 0\end{bmatrix}, D=\begin{bmatrix}0\\ 0\end{bmatrix}$$

$$x=\frac{(1.624s^2-510.1}{(s^4+8.447s^3-709.2s^2-2653s)}$$

$$\theta_c=\frac{(8.427s+7.485e-15)}{s^3+8.447s^2-709.2s-2653)}$$

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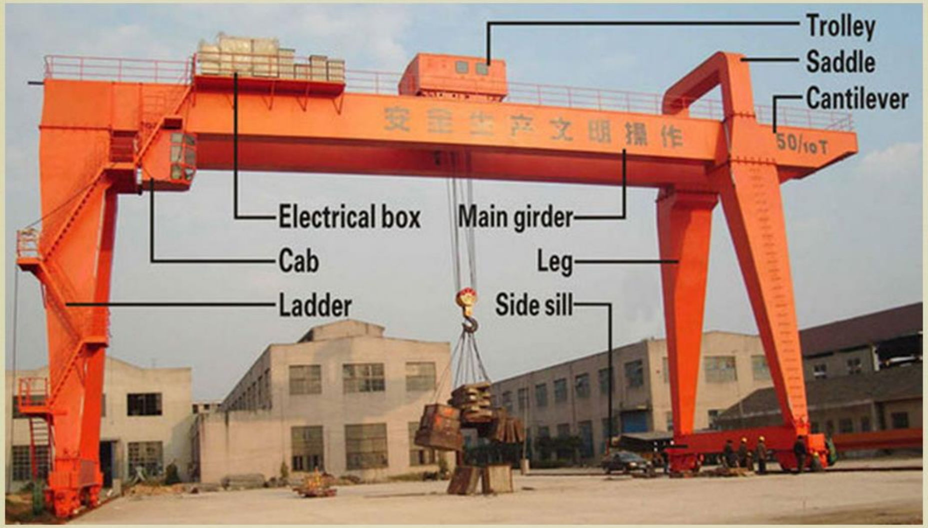
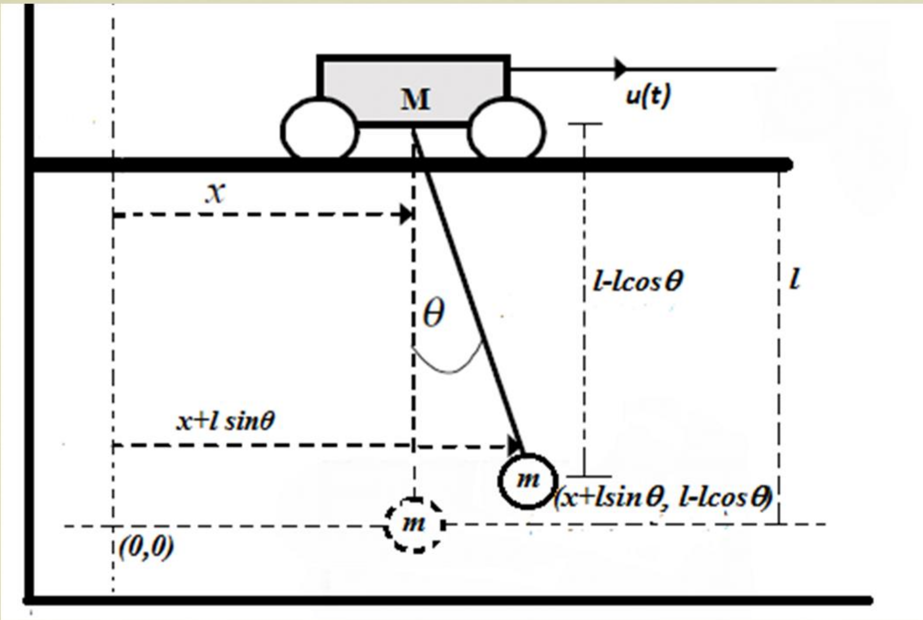
Gantry Crane System – modeling and control

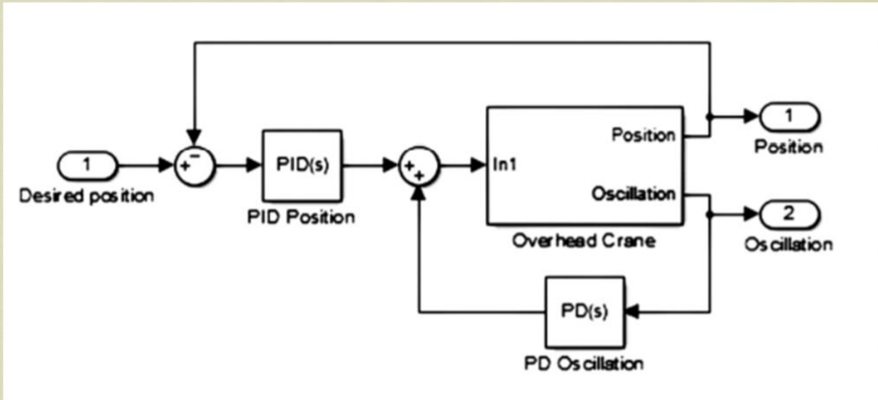


Mod-PSO

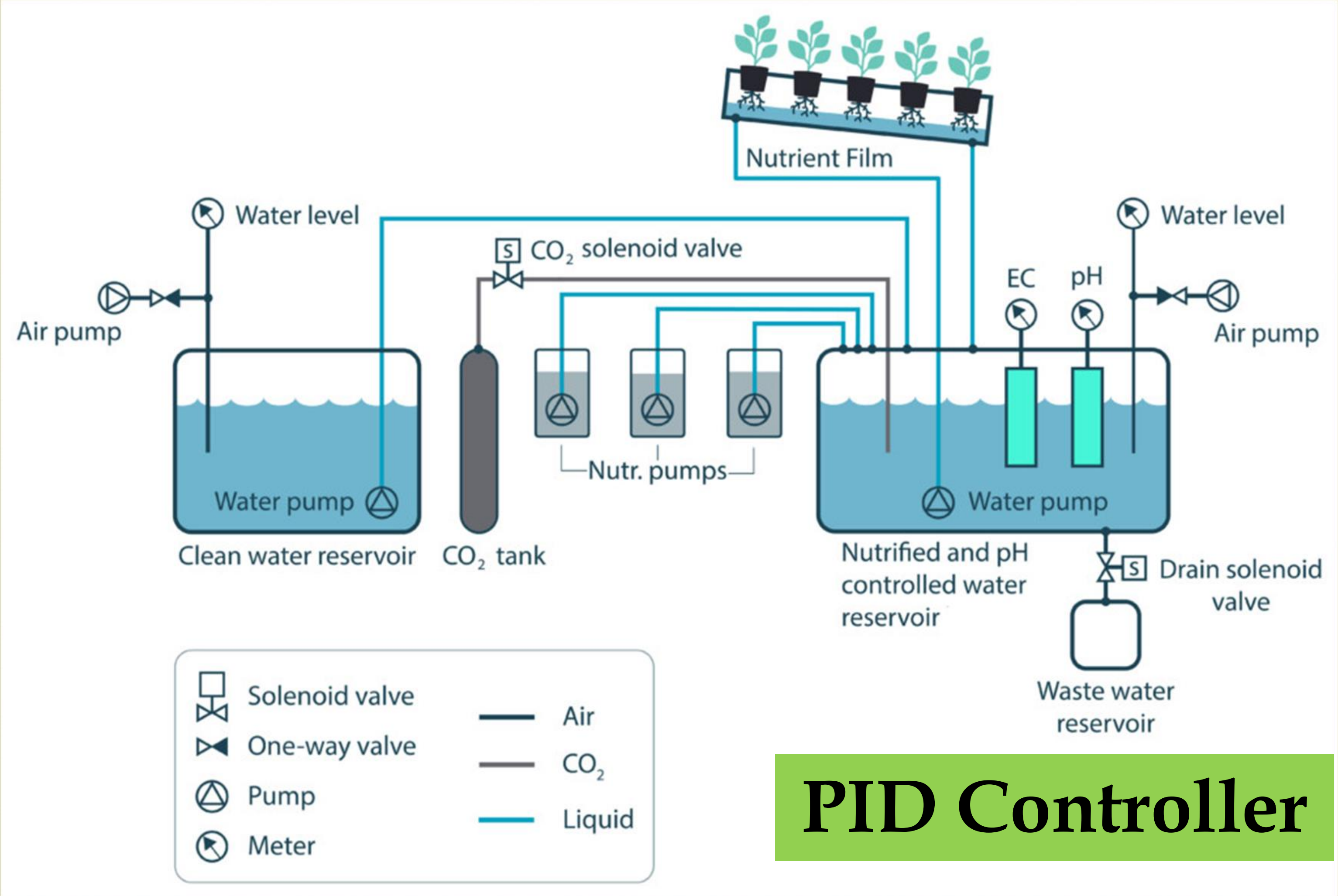
PID Controller

LQR/LQG





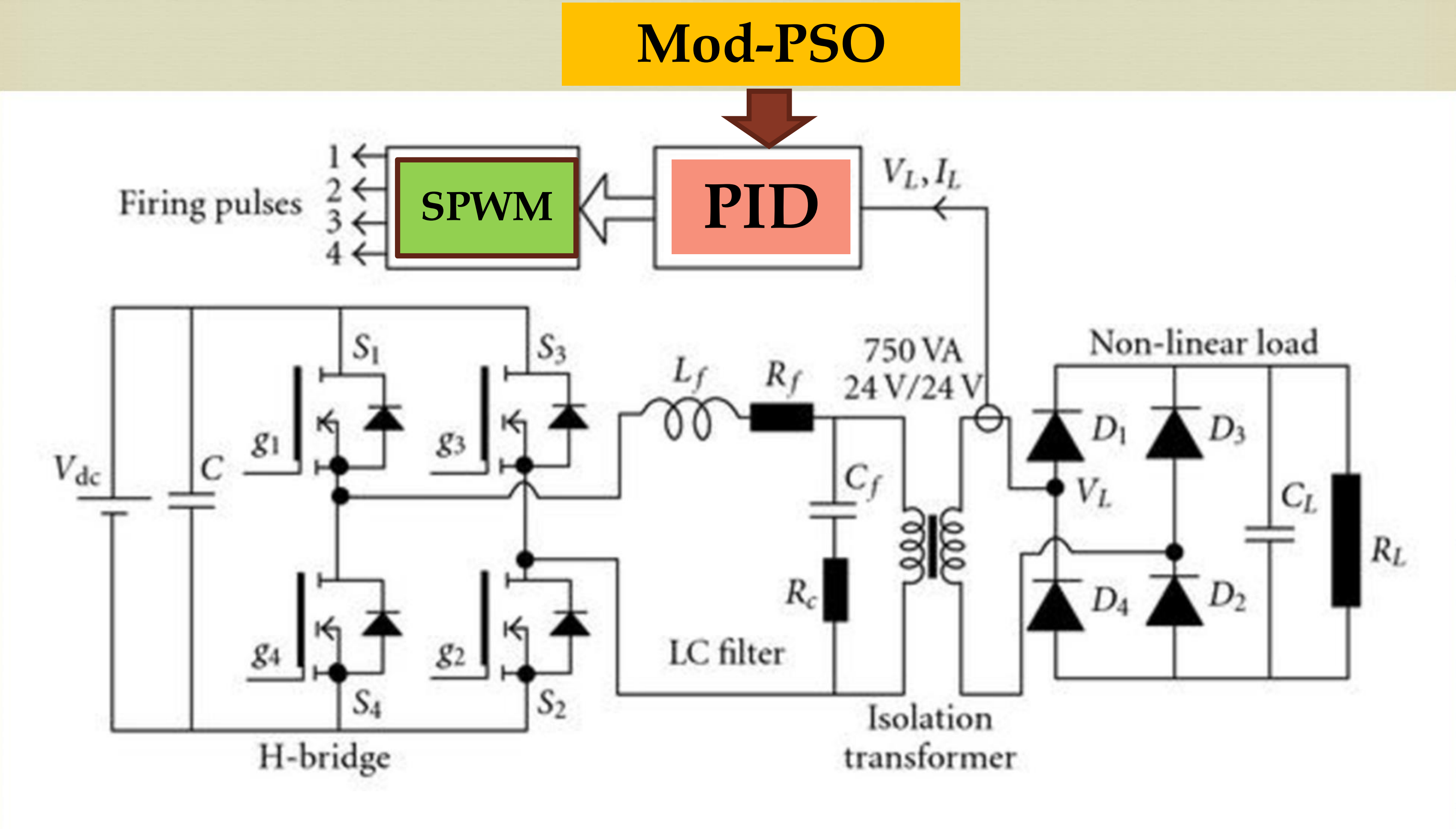
Hydroponic System – modeling and control



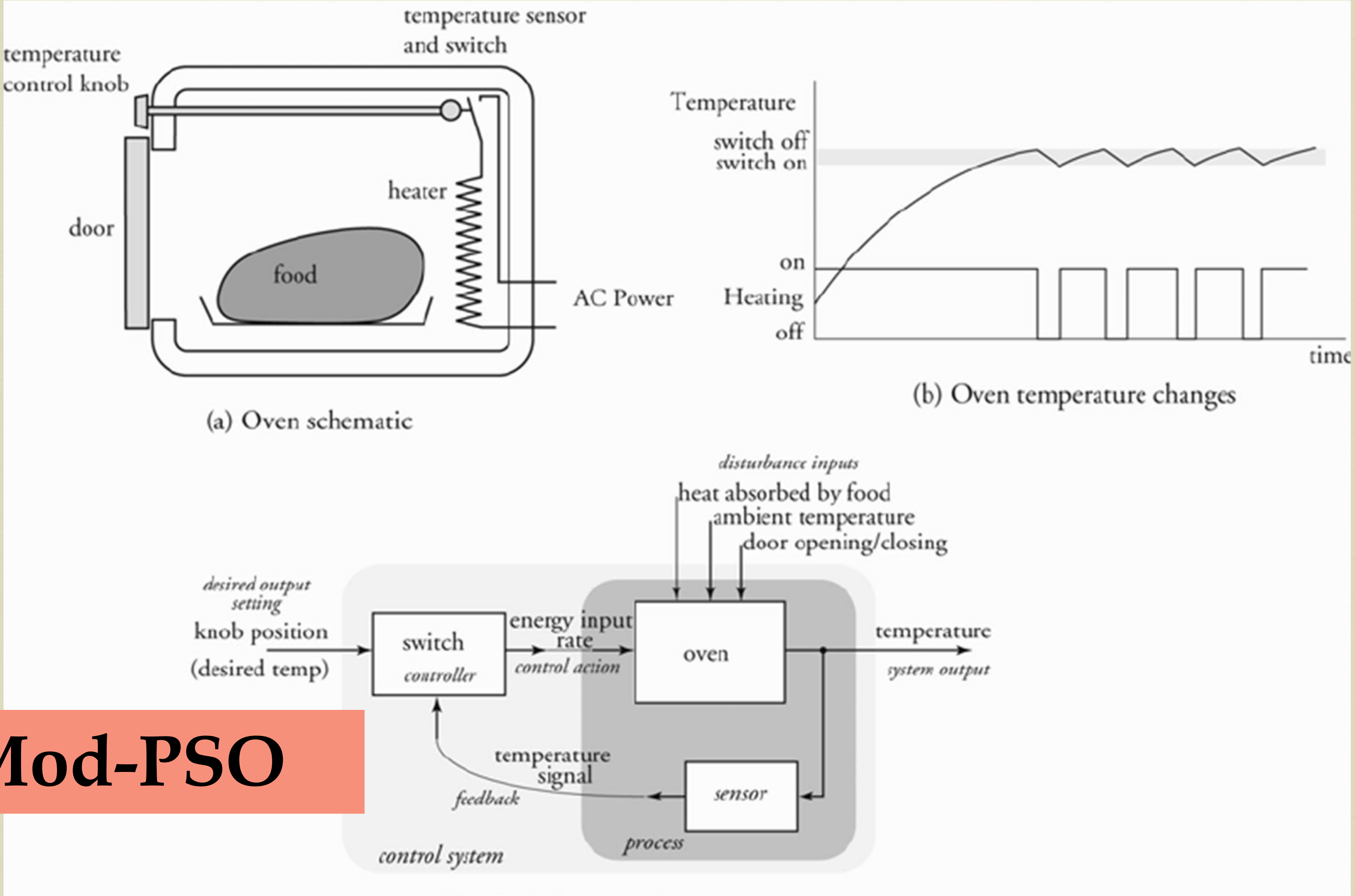
PID Controller

Mod-PSO

Inverter Circuit – modeling and control



Heater and Oven System – modeling and control

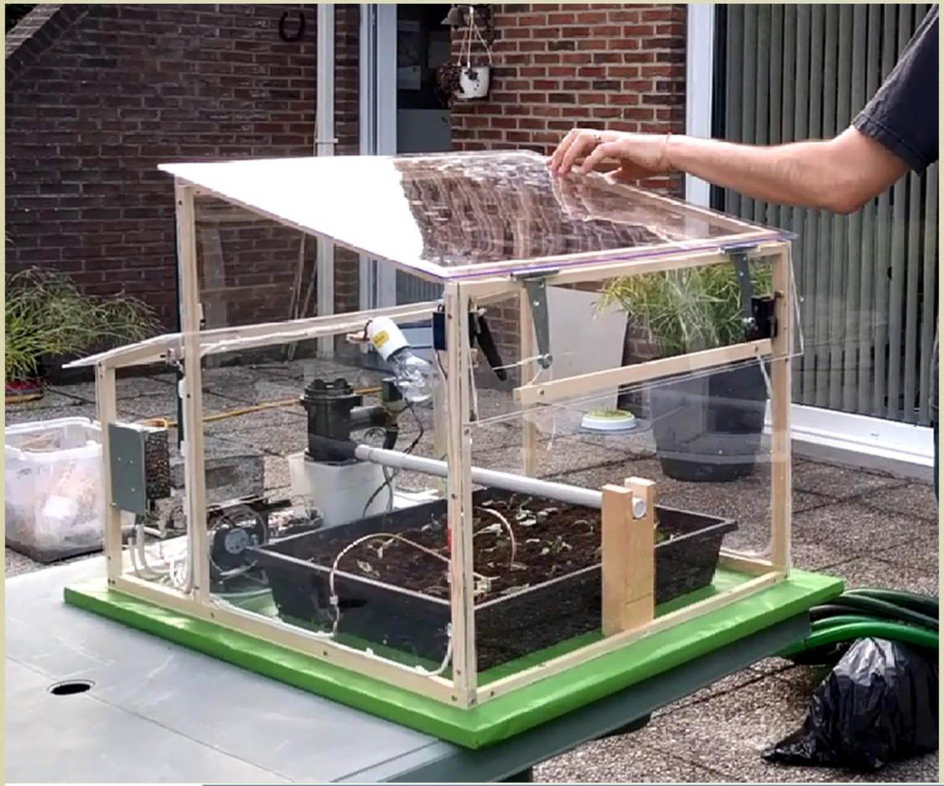


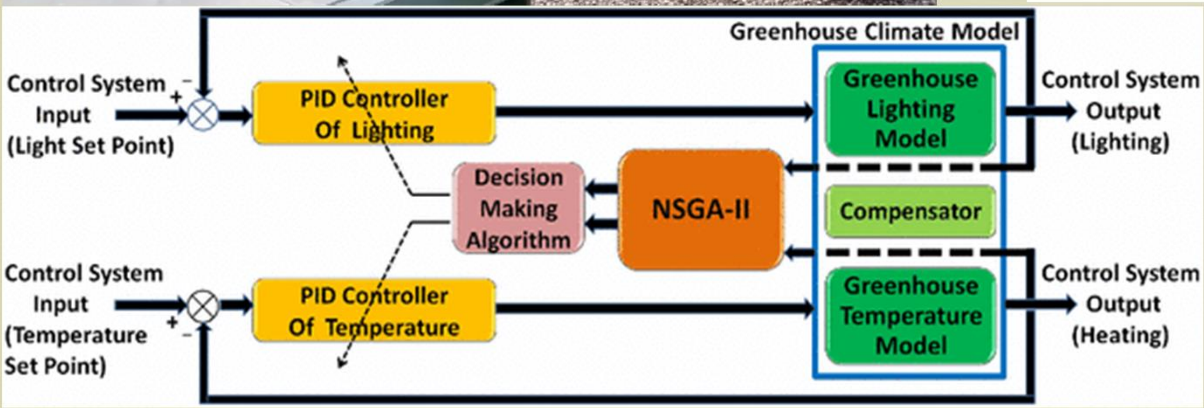
(c) Block diagram of control system

Mod-PSO

PID Controller

Greenhouse System – modeling and control





Optimization Design of **PID Controller** using **Mod-PSO** for **a Unicycle Bike**

PLANT ?

CONTROLLER ?

METODE ?

Optimization Problem in Circuit Design

Amplifier : low noise; high S/N ratio; low power; highest band width; linearity
Filter : low noise; low power
Converter / Inverter : low noise; low THD, low power
Switching circuit : low noise; low THD; low power
ADC / DAC : low noise; low power
Power supply : low noise
Oscillator : low noise; low power
Transmission circuit : low noise; high S/N ratio

Main performance

Low Noise :
minimization problem

Artificial Intelligences (AI) :
PSO, GA, ACO, BA, CSO, etc

自己紹介