Drawing examples in LaTeX

Giuseppe Silano

April 11, 2020

Contents

Introduction **i**

The aim of document . . . i

1 Block Diagram **1**

1.1 Example 1 . . . 1
1.2 Example 2 . . . 1
1.3 Example 3 . . . 2
1.4 Example 4 . . . 2
1.5 Example 5 . . . 3
1.6 Example 6 . . . 3
1.7 Example 7 . . . 3
1.8 Example 8 . . . 4
1.9 Example 9 . . . 4
1.10 Example 10 . . . 5
1.11 Example 11 . . . 5
1.12 Example 12 . . . 6
1.13 Example 13 . . . 6
1.14 Example 14 . . . 7
1.15 Example 15 . . . 7
1.16 Example 16 . . . 7
1.17 Example 17 . . . 8
1.18 Example 18 . . . 8
1.19 Example 19 . . . 9
1.20 Example 20 . . . 9
1.21 Example 21 . . . 10
1.22 Example 22 . . . 10
1.23 Example 23 . . . 11
1.24 Example 24 . . . 11
1.25 Example 25 . . . 12
1.26 Example 26 . . . 12
1.27 Example 27 . . . 13
1.28 Example 28 . . . 13
1.29 Example 29 . . . 14
1.30 Example 30 . . . 14
1.31 Example 31 . . . 15

1.32 Example 32 15
1.33 Example 33 16
1.34 Example 34 16
1.35 Example 35 17

2 Matlab Plots 18
2.1 Example 1 18
2.2 Example 2 19
2.3 Example 3 19
2.4 Example 4 20

3 Drawing on Images 21
3.1 Example 1 21
3.2 Example 2 22
3.3 Example 3 22
3.4 Example 4 23
3.5 Example 5 23
3.6 Example 6 24
3.7 Example 7 24
3.8 Example 8 25
3.9 Example 9 25
3.10 Example 10 26

4 Various 27
4.1 Example 1 27
4.2 Example 2 27
4.3 Example 3 28
4.4 Example 4 28
4.5 Example 5 29
4.6 Example 6 29
4.7 Example 7 29
4.8 Example 8 30
4.9 Example 9 30
4.10 Example 10 31
4.11 Example 11 31
4.12 Example 12 31
4.13 Example 13 32
4.14 Example 14 32
4.15 Example 15 33
4.16 Example 16 33
4.17 Example 17 33
4.18 Example 18 34
4.19 Example 19 34
4.20 Example 20 35
4.21 Example 21 35
4.22 Example 22 36

4.23 Example 23 36
4.24 Example 24 37
4.25 Example 25 37
4.26 Example 26 38
4.27 Example 27 38
4.28 Example 28 39
4.29 Example 29 39
4.30 Example 30 39
4.31 Example 36 39

Introduction

The aim of document

The aim of this file is to help people interested in learning how to use LaTeX for drawing. In particular, already structured examples will help to develop one's own through the source code provided. The draws have been made during my research activity as PhD candidate.

The file is divided into four main chapters (parts):

- *Block Diagrams* (see Ch. 1): this part contains block diagrams;
- *Matlab Plots* (see Ch. 2): this part contains MATLAB® and the MATLAB package *matlab2tikz*[1].
- *Drawing on Images* (see Ch. 3): this part contains draws made on image files;
- *Various* (see Ch. 4): this part contains several drawings that do not belong to the sections listed above.

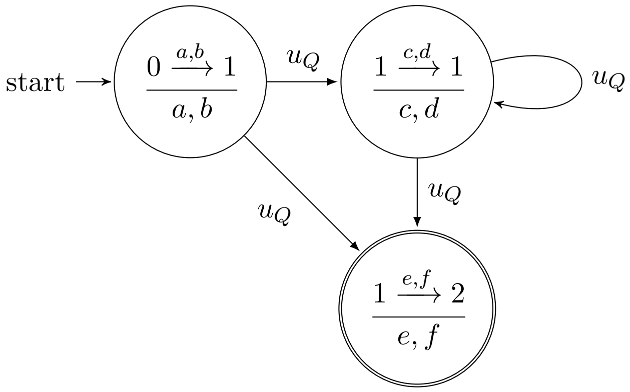
---

[1] It is available at the link `https://github.com/matlab2tikz/matlab2tikz`

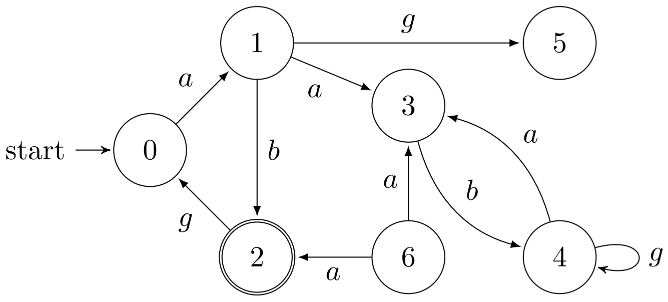
Chapter 1

Block Diagram

1.1 Example 1


start
$0 \xrightarrow{a,b} 1$
a, b
u_Q
$1 \xrightarrow{c,d} 1$
c, d
u_Q
u_Q
u_Q
$1 \xrightarrow{e,f} 2$
e, f

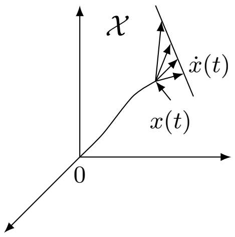
1.2 Example 2


start
0
1
2
3
4
5
6
a
g
b
a
g
a
a
b
a
g

1.3 Example 3

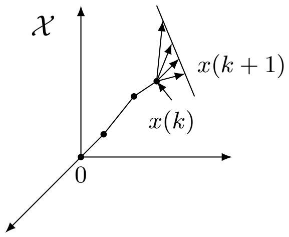
Continuos-time:

$$\boxed{\begin{aligned}\dot{x}(t) &= Ax(t) + Bu(t)\\ y(t) &= Cx(t)\end{aligned}}$$

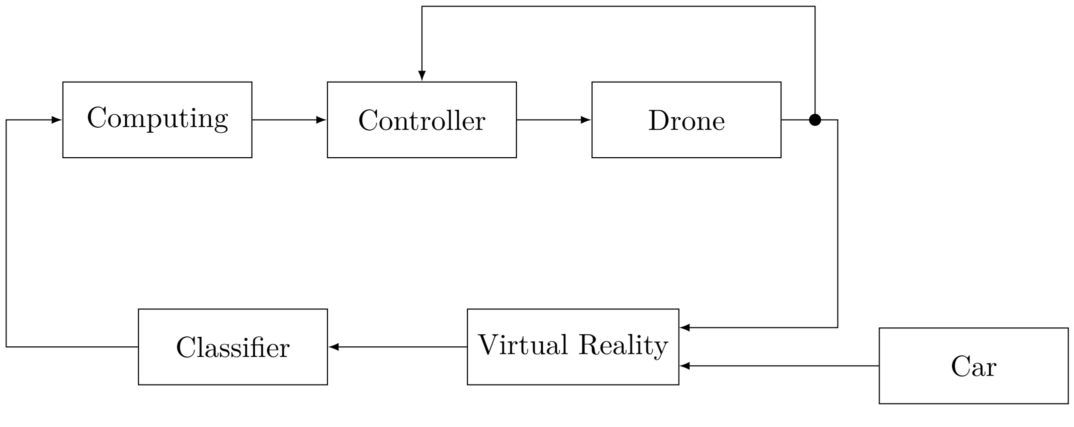

$\mathcal{X}$
$\dot{x}(t)$
$x(t)$
0

Discrete-time:

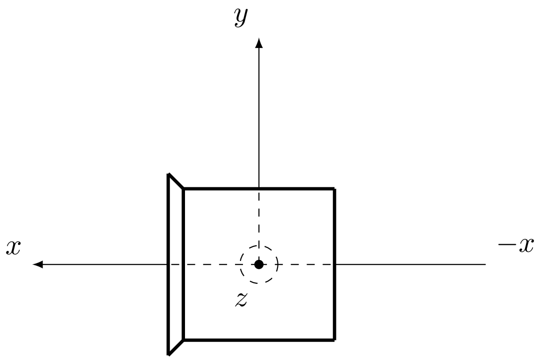
$$\boxed{\begin{aligned}x(k+1) &= Ax(k) + Bu(k)\\ y(k) &= Cx(k)\end{aligned}}$$


$\mathcal{X}$
$x(k+1)$
$x(k)$
0

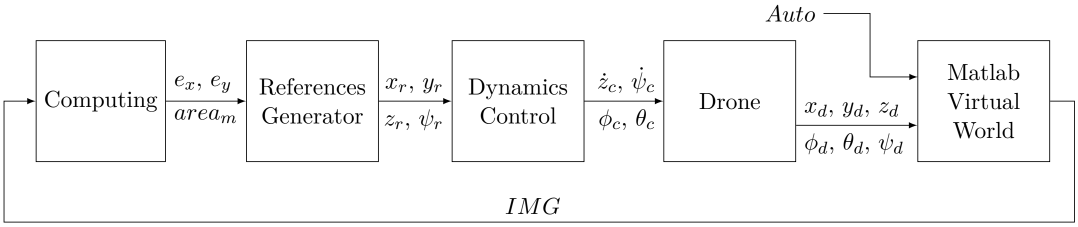
1.4 Example 4


Computing
Controller
Drone
Classifier
Virtual Reality
Car

1.5 Example 5

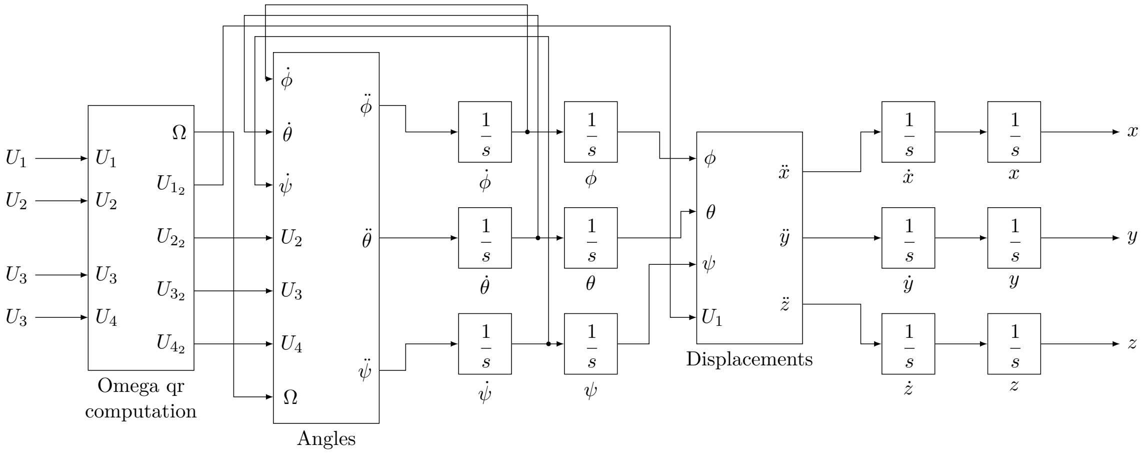


1.6 Example 6



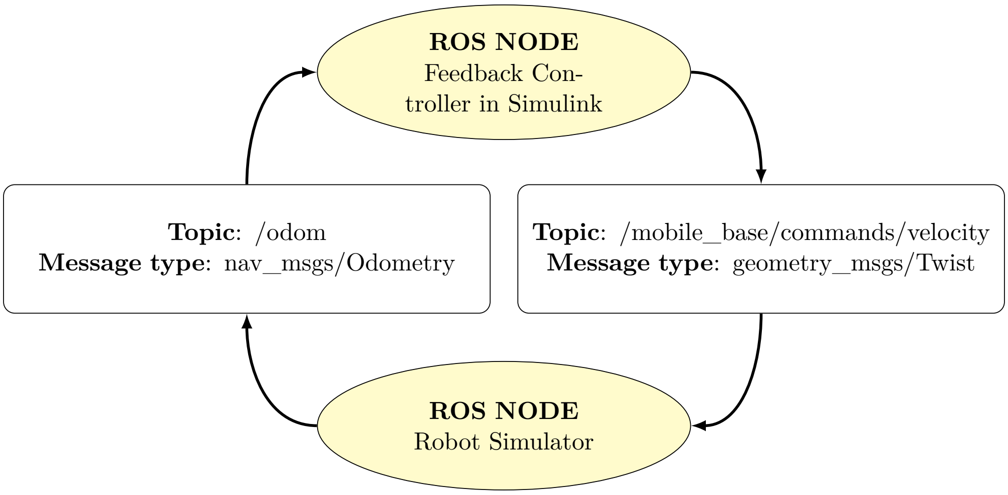
Auto
Computing
e_x, e_y
$area_m$
References Generator
x_r, y_r
z_r, ψ_r
Dynamics Control
$\dot{z}_c$, $\dot{\psi}_c$
ϕ_c, θ_c
Drone
x_d, y_d, z_d
ϕ_d, θ_d, ψ_d
Matlab Virtual World
IMG

1.7 Example 7

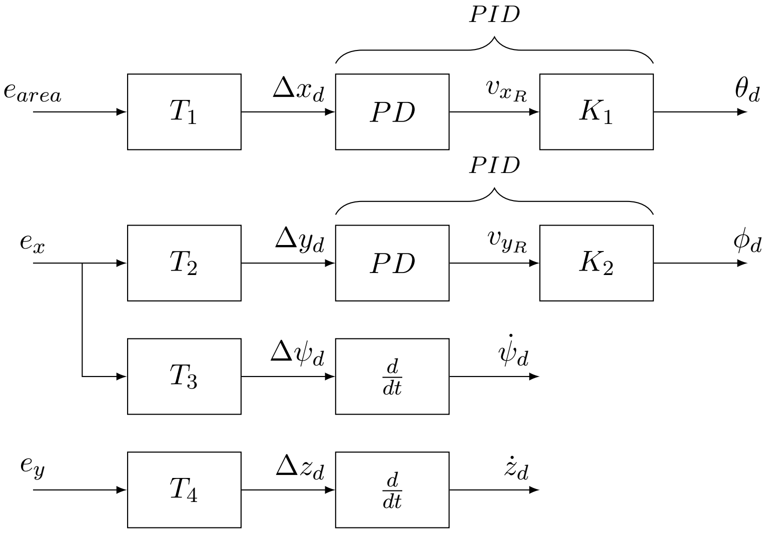


U_1
U_2
U_3
U_3
U_1
U_2
U_3
U_4
Ω
U_{1_2}
U_{2_2}
U_{3_2}
U_{4_2}
Omega qr computation
$\dot{\phi}$
$\dot{\theta}$
$\dot{\psi}$
U_2
U_3
U_4
Ω
$\ddot{\phi}$
$\ddot{\theta}$
$\ddot{\psi}$
Angles
$\frac{1}{s}$
$\dot{\phi}$
$\dot{\theta}$
$\dot{\psi}$
ϕ
θ
ψ
ϕ
θ
ψ
U_1
$\ddot{x}$
$\ddot{y}$
$\ddot{z}$
Displacements
$\dot{x}$
$\dot{y}$
$\dot{z}$
x
y
z
x
y
z

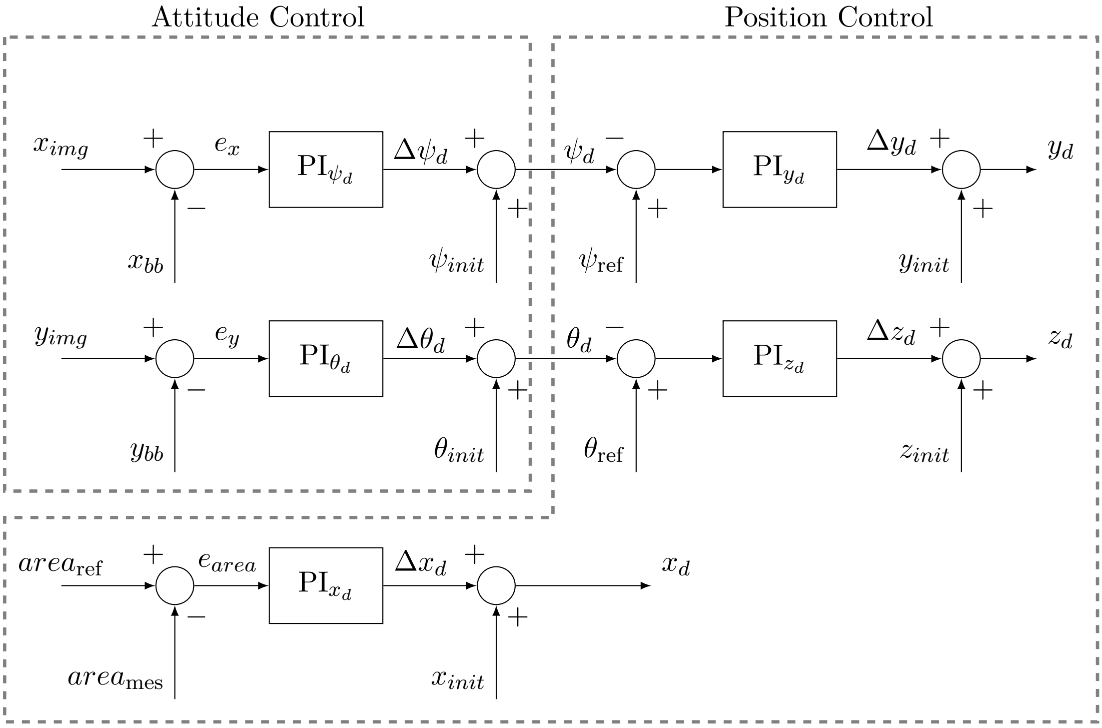
1.8 Example 8


ROS NODE
Feedback Controller in Simulink
Topic: /odom
Message type: nav_msgs/Odometry
Topic: /mobile_base/commands/velocity
Message type: geometry_msgs/Twist
ROS NODE
Robot Simulator

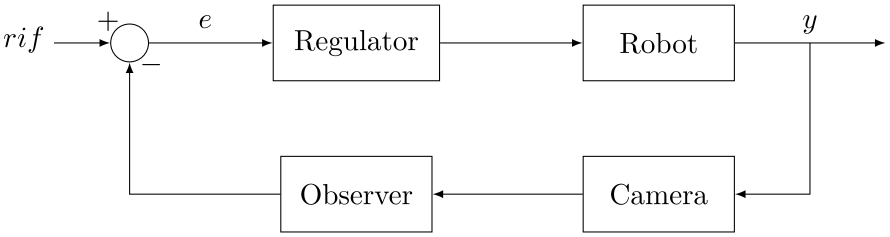
1.9 Example 9


PID
e_{area}
T_1
Δx_d
PD
v_{x_R}
K_1
θ_d
PID
e_x
T_2
Δy_d
PD
v_{y_R}
K_2
ϕ_d
T_3
$\Delta\psi_d$
$\frac{d}{dt}$
$\dot{\psi}_d$
e_y
T_4
Δz_d
$\frac{d}{dt}$
$\dot{z}_d$

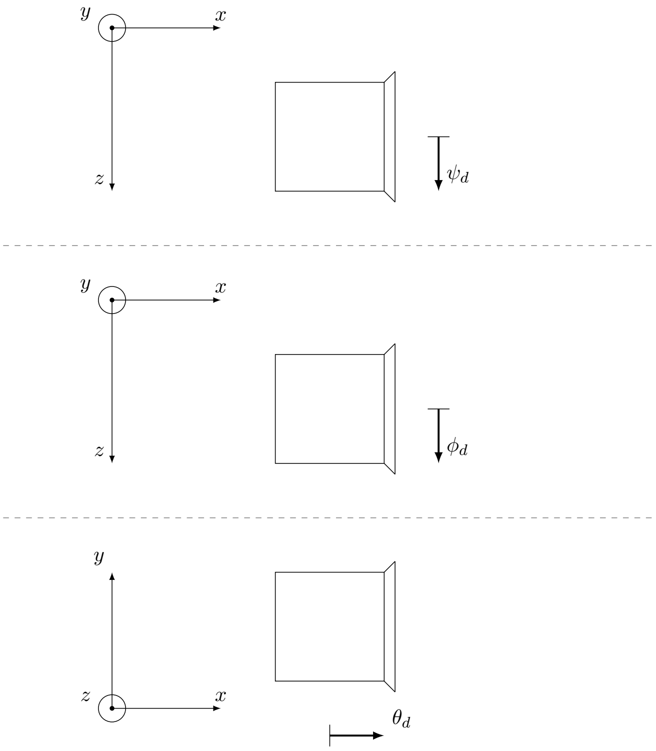
1.10 Example 10


Attitude Control
Position Control
x_{img}
e_x
PI_{ψ_d}
$\Delta\psi_d$
x_{bb}
ψ_{init}
ψ_d
PI_{y_d}
Δy_d
y_d
ψ_{ref}
y_{init}
y_{img}
e_y
PI_{θ_d}
$\Delta\theta_d$
y_{bb}
θ_{init}
θ_d
PI_{z_d}
Δz_d
z_d
θ_{ref}
z_{init}
$area_{\mathrm{ref}}$
e_{area}
PI_{x_d}
Δx_d
x_d
$area_{\mathrm{mes}}$
x_{init}
+
−

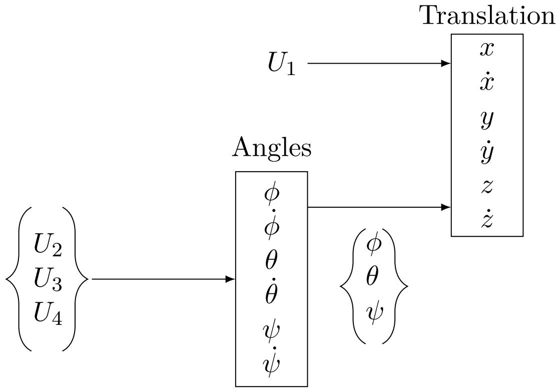
1.11 Example 11


rif
e
Regulator
Robot
y
Observer
Camera
+
−

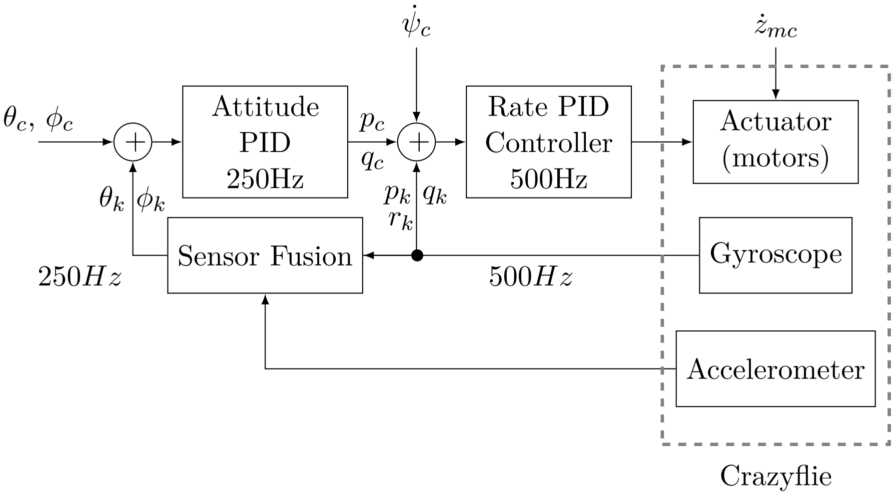
1.12 Example 12


y
x
z
ψ_d
y
x
z
ϕ_d
y
z
x
θ_d

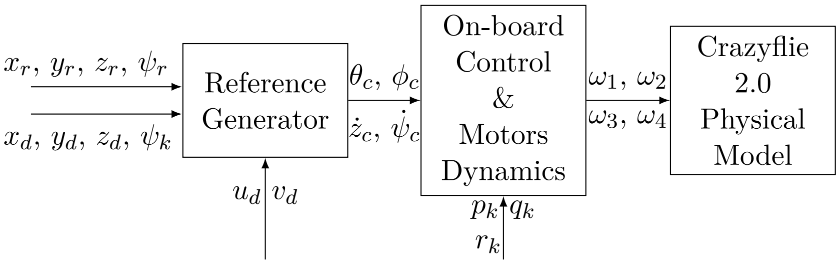
1.13 Example 13


Translation
U_1
x
$\dot{x}$
y
$\dot{y}$
z
$\dot{z}$
Angles
ϕ
$\dot{\phi}$
θ
$\dot{\theta}$
ψ
$\dot{\psi}$
U_2
U_3
U_4
ϕ
θ
ψ

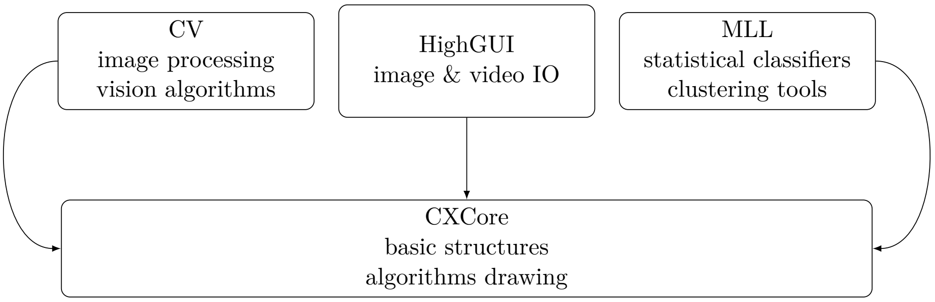
1.14 Example 14


θ_c, ϕ_c
Attitude PID 250Hz
p_c
q_c
$\dot{\psi}_c$
Rate PID Controller 500Hz
$\dot{z}_{mc}$
Actuator (motors)
θ_k ϕ_k
p_k q_k
r_k
Sensor Fusion
$250Hz$
$500Hz$
Gyroscope
Accelerometer
Crazyflie

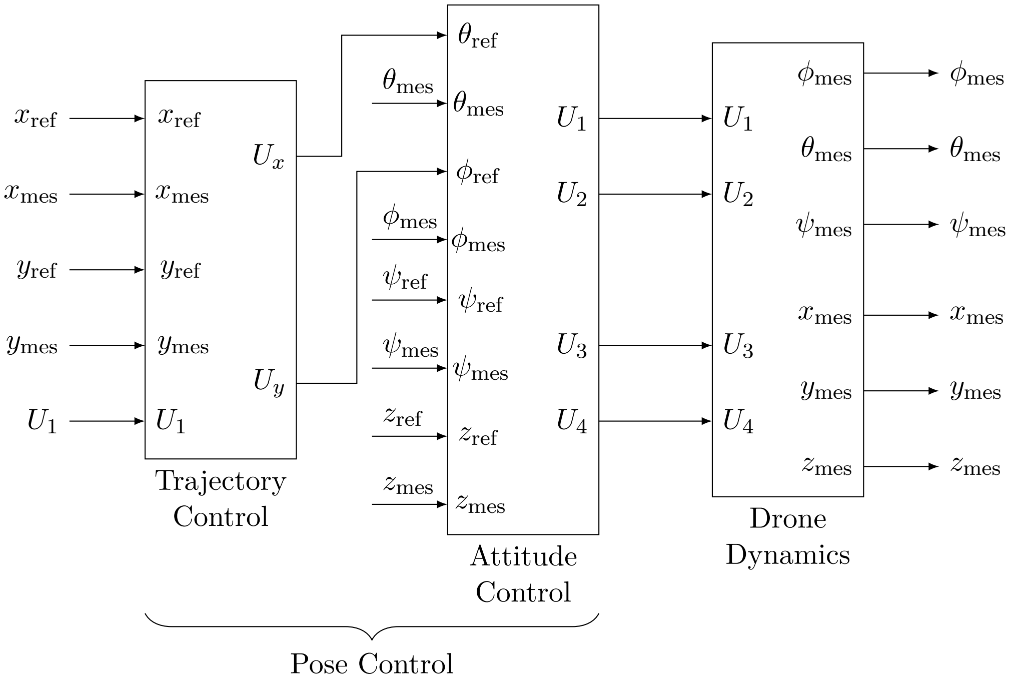
1.15 Example 15


x_r, y_r, z_r, ψ_r
x_d, y_d, z_d, ψ_k
Reference Generator
u_d v_d
θ_c, ϕ_c
$\dot{z}_c$, $\dot{\psi}_c$
On-board Control & Motors Dynamics
p_k q_k
r_k
ω_1, ω_2
ω_3, ω_4
Crazyflie 2.0 Physical Model

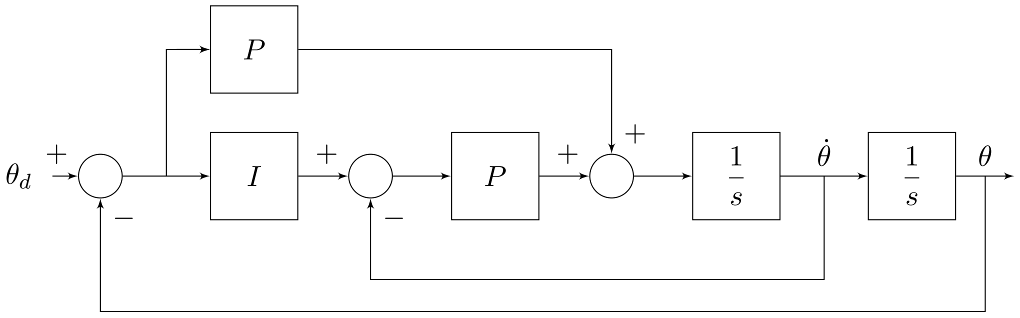
1.16 Example 16


CV
image processing
vision algorithms
HighGUI
image & video IO
MLL
statistical classifiers
clustering tools
CXCore
basic structures
algorithms drawing

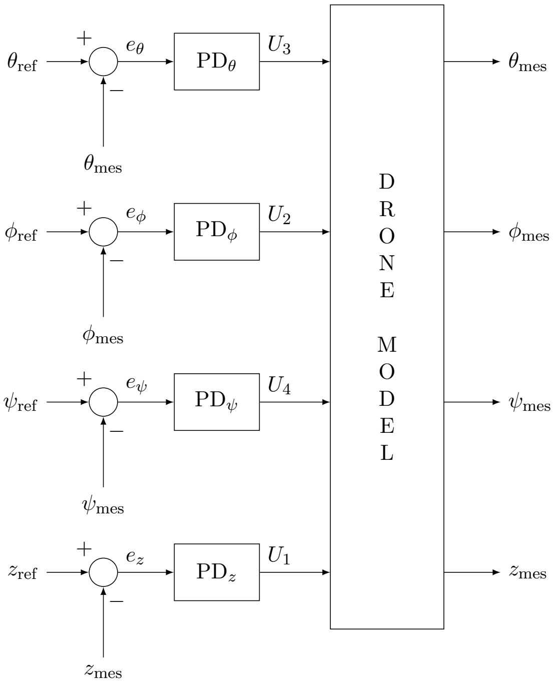
1.17 Example 17


x_{ref}
x_{mes}
y_{ref}
y_{mes}
U_1
x_{ref}
x_{mes}
y_{ref}
y_{mes}
U_1
U_x
U_y
Trajectory Control
θ_{ref}
θ_{mes}
θ_{mes}
ϕ_{ref}
ϕ_{mes}
ϕ_{mes}
ψ_{ref}
ψ_{ref}
ψ_{mes}
ψ_{mes}
z_{ref}
z_{ref}
z_{mes}
z_{mes}
U_1
U_2
U_3
U_4
Attitude Control
U_1
U_2
U_3
U_4
ϕ_{mes}
θ_{mes}
ψ_{mes}
x_{mes}
y_{mes}
z_{mes}
Drone Dynamics
ϕ_{mes}
θ_{mes}
ψ_{mes}
x_{mes}
y_{mes}
z_{mes}
Pose Control

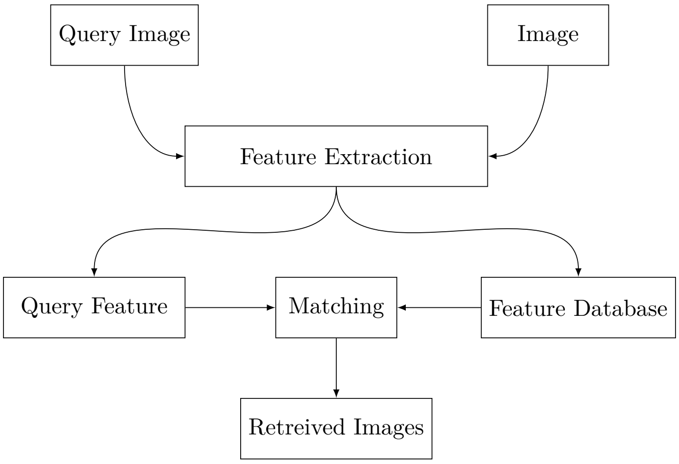
1.18 Example 18


θ_d
+
−
P
I
+
−
P
+
+
$\frac{1}{s}$
$\dot{\theta}$
$\frac{1}{s}$
θ

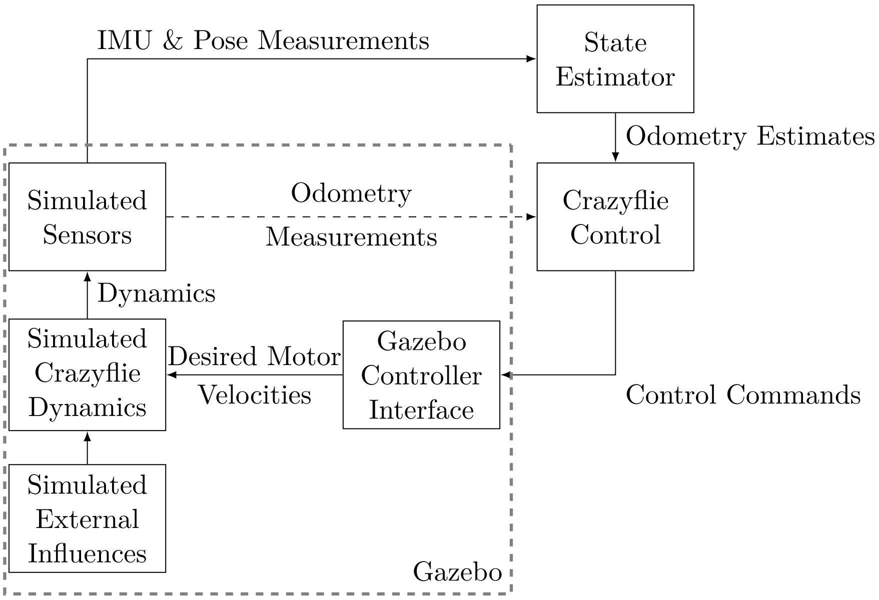
1.19 Example 19


θ_{ref}
+
−
e_θ
PD$_\theta$
U_3
θ_{mes}
θ_{mes}
ϕ_{ref}
e_ϕ
PD$_\phi$
U_2
ϕ_{mes}
ϕ_{mes}
ψ_{ref}
e_ψ
PD$_\psi$
U_4
ψ_{mes}
ψ_{mes}
z_{ref}
e_z
PD$_z$
U_1
z_{mes}
z_{mes}
DRONE MODEL

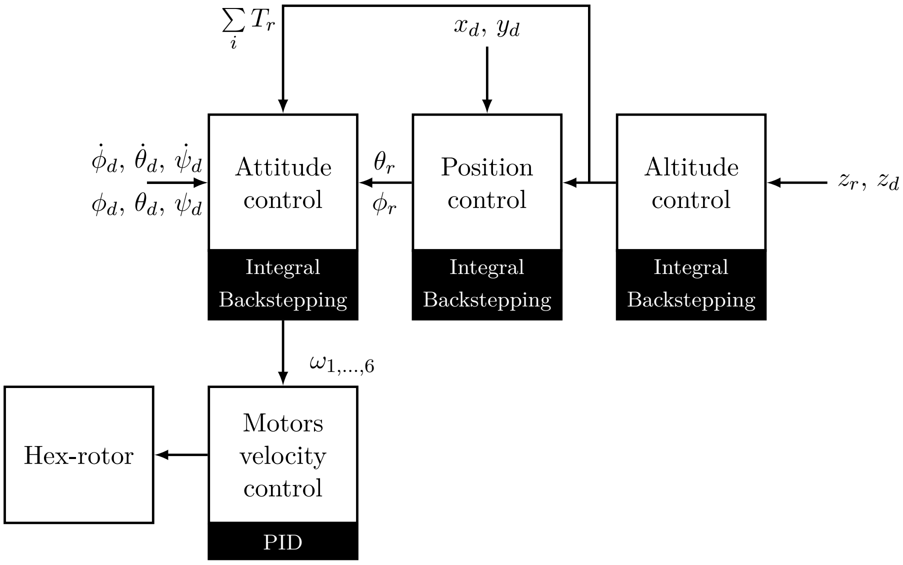
1.20 Example 20


Query Image
Image
Feature Extraction
Query Feature
Matching
Feature Database
Retreived Images

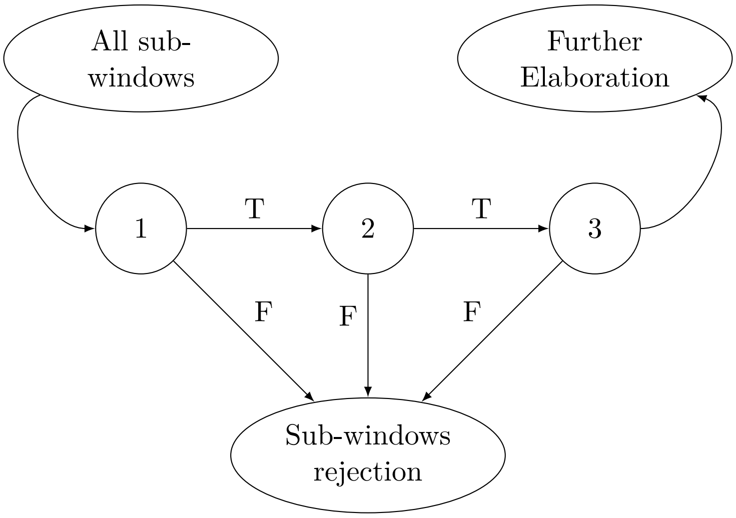
1.21 Example 21


IMU & Pose Measurements
State Estimator
Odometry Estimates
Simulated Sensors
Odometry Measurements
Crazyflie Control
Dynamics
Simulated Crazyflie Dynamics
Desired Motor Velocities
Gazebo Controller Interface
Control Commands
Simulated External Influences
Gazebo

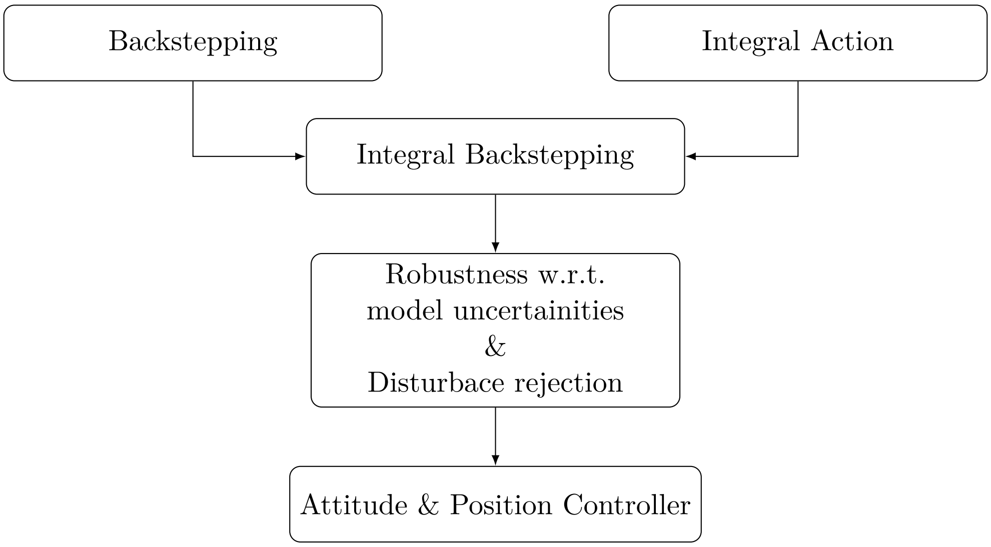
1.22 Example 22


$\sum_i T_r$
x_d, y_d
$\dot{\phi}_d, \dot{\theta}_d, \dot{\psi}_d$
ϕ_d, θ_d, ψ_d
Attitude control
Integral Backstepping
θ_r
ϕ_r
Position control
Integral Backstepping
Altitude control
Integral Backstepping
z_r, z_d
$\omega_{1,\ldots,6}$
Hex-rotor
Motors velocity control
PID

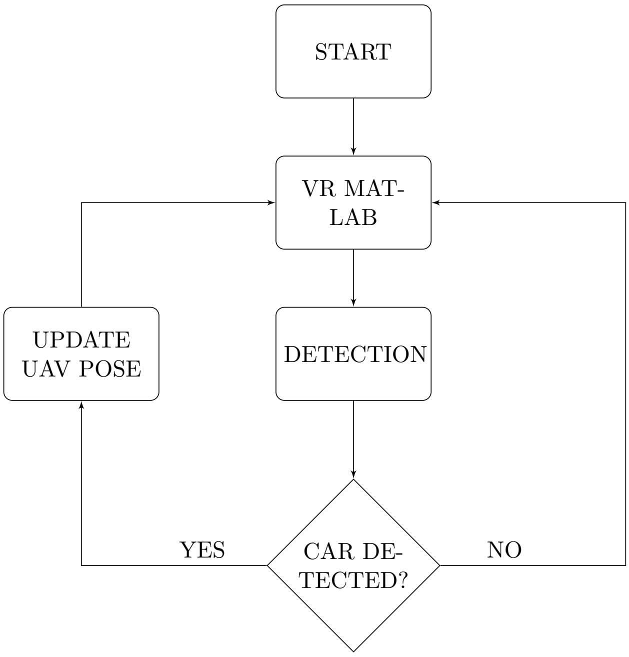
1.23 Example 23


All sub-
windows
Further
Elaboration
1
T
2
T
3
F
F
F
Sub-windows
rejection

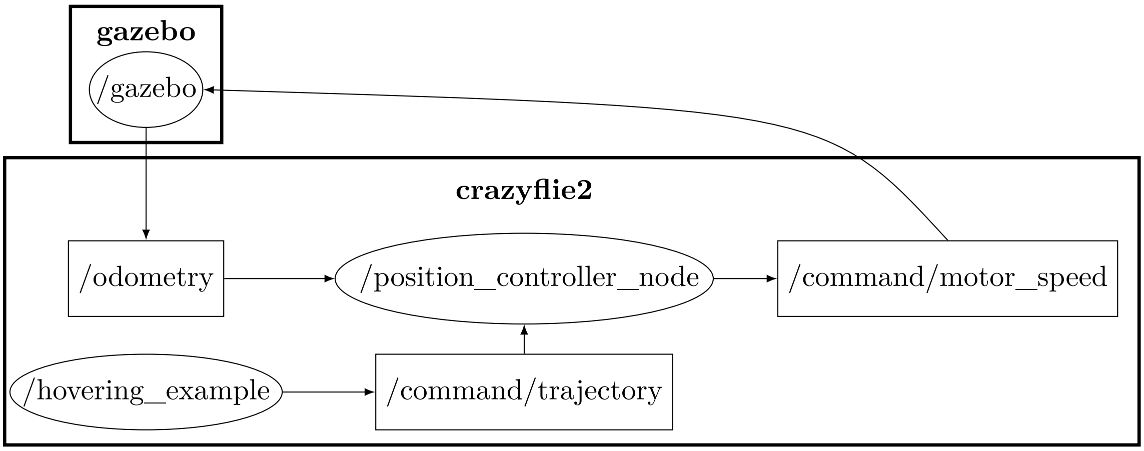
1.24 Example 24


Backstepping
Integral Action
Integral Backstepping
Robustness w.r.t.
model uncertainities
&
Disturbace rejection
Attitude & Position Controller

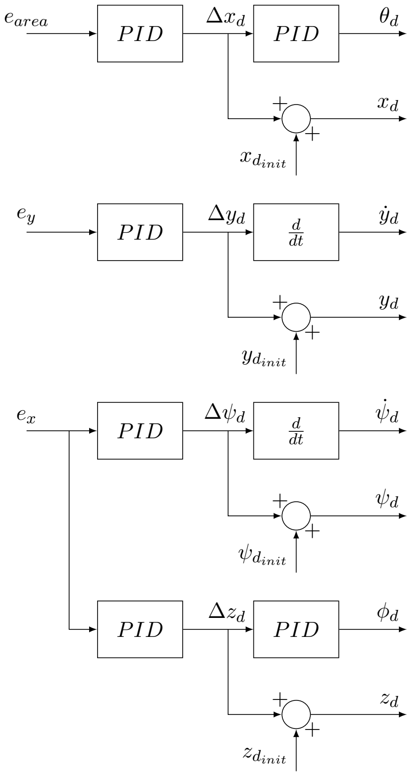
1.25 Example 25


START
VR MAT-LAB
UPDATE UAV POSE
DETECTION
CAR DE-TECTED?
YES
NO

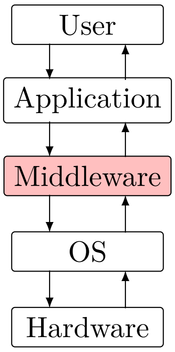
1.26 Example 26


gazebo
/gazebo
crazyflie2
/odometry
/position_controller_node
/command/motor_speed
/hovering_example
/command/trajectory

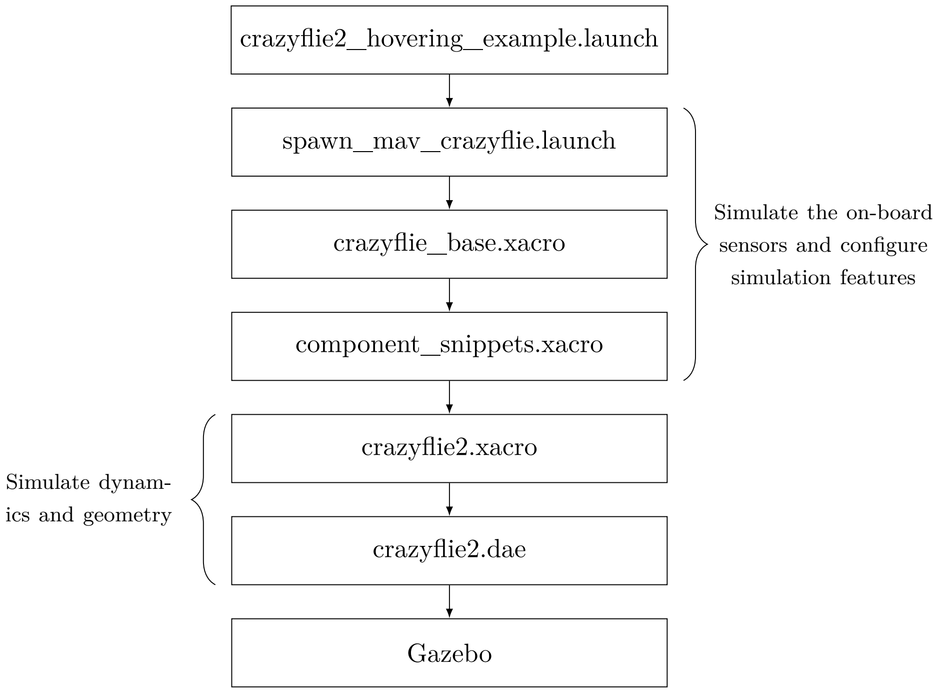
1.27 Example 27


e_{area}
PID
Δx_d
PID
θ_d
x_d
$x_{d_{init}}$
e_y
PID
Δy_d
$\frac{d}{dt}$
$\dot{y}_d$
y_d
$y_{d_{init}}$
e_x
PID
$\Delta \psi_d$
$\frac{d}{dt}$
$\dot{\psi}_d$
ψ_d
$\psi_{d_{init}}$
PID
Δz_d
PID
ϕ_d
z_d
$z_{d_{init}}$
+

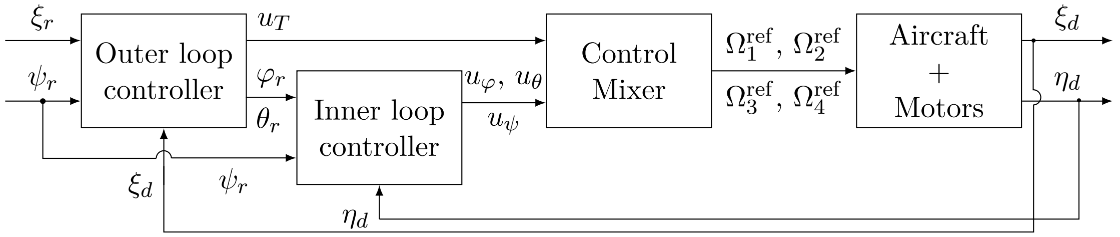
1.28 Example 28


User
Application
Middleware
OS
Hardware

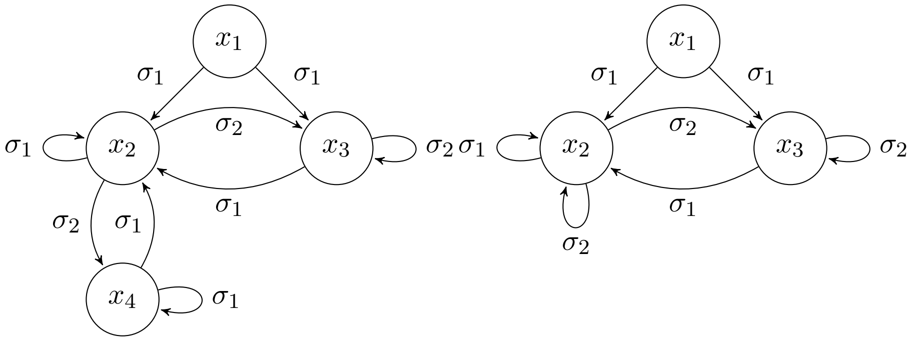
1.29 Example 29


crazyflie2_hovering_example.launch
spawn_mav_crazyflie.launch
crazyflie_base.xacro
component_snippets.xacro
Simulate the on-board sensors and configure simulation features
crazyflie2.xacro
crazyflie2.dae
Simulate dynamics and geometry
Gazebo

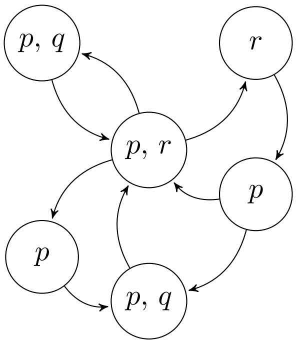
1.30 Example 30


ξ_r
ψ_r
Outer loop controller
u_T
φ_r
θ_r
Inner loop controller
u_φ, u_θ
u_ψ
Control Mixer
Ω_1^{ref}, Ω_2^{ref}
Ω_3^{ref}, Ω_4^{ref}
Aircraft + Motors
ξ_d
η_d
ξ_d
ψ_r
η_d

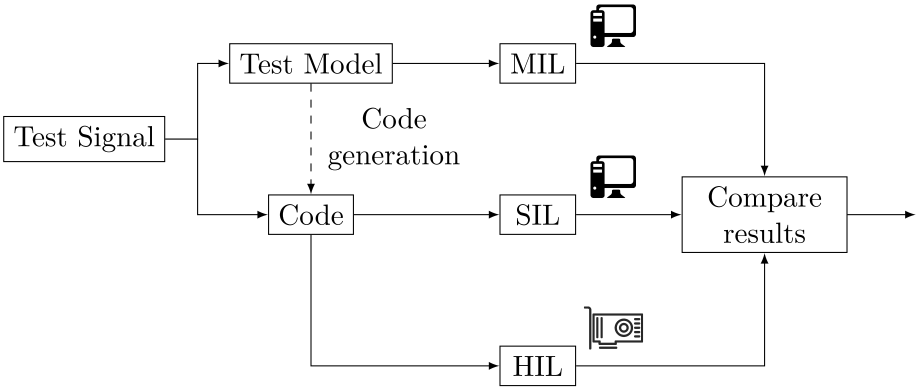
1.31 Example 31


x_1
σ_1
σ_1
σ_1
x_2
σ_2
x_3
σ_2
σ_1
σ_2
σ_1
x_4
σ_1
x_1
σ_1
σ_1
σ_1
x_2
σ_2
x_3
σ_2
σ_1
σ_2

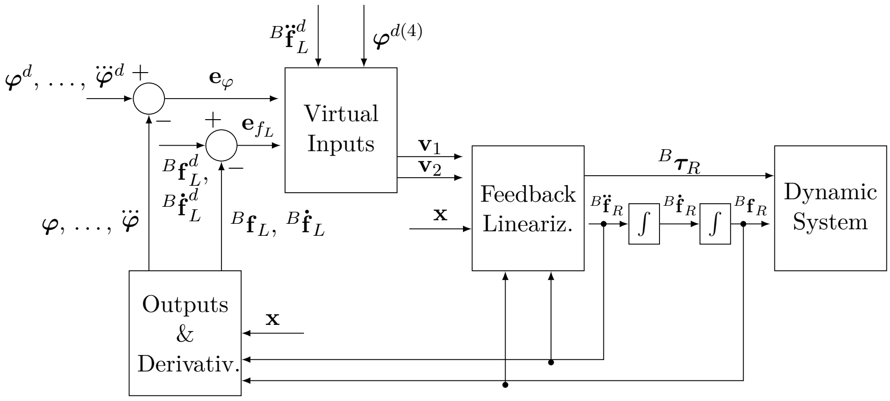
1.32 Example 32



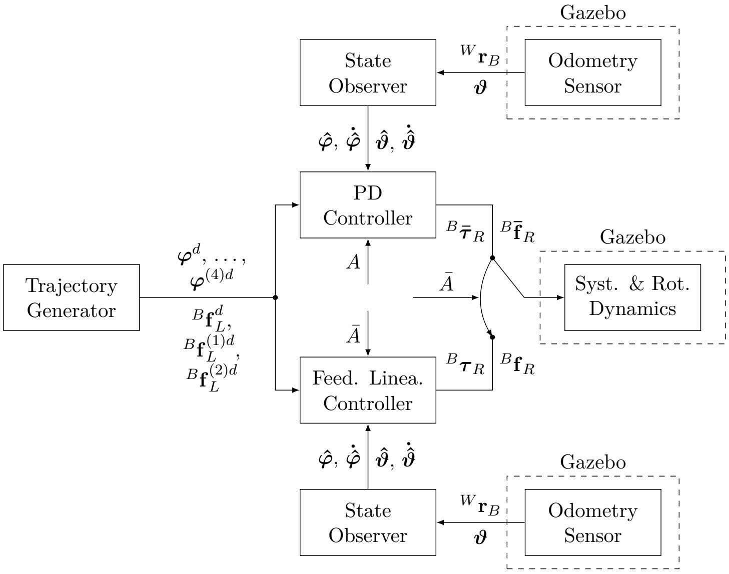
1.33 Example 33


Test Signal
Test Model
Code generation
Code
MIL
SIL
HIL
Compare results

1.34 Example 34


$^B\ddot{\mathbf{f}}_L^d$
$\boldsymbol{\varphi}^{d(4)}$
$\boldsymbol{\varphi}^d, \ldots, \dddot{\boldsymbol{\varphi}}^d$ +
$\mathbf{e}_\varphi$
−
+
$\mathbf{e}_{f_L}$
Virtual Inputs
$^B\mathbf{f}_L^d$,
$^B\dot{\mathbf{f}}_L^d$
−
$\boldsymbol{\varphi}, \ldots, \ddot{\boldsymbol{\varphi}}$
$^B\mathbf{f}_L$, $^B\dot{\mathbf{f}}_L$
$\mathbf{v}_1$
$\mathbf{v}_2$
$\mathbf{x}$
Feedback Lineariz.
$^B\boldsymbol{\tau}_R$
$^B\ddot{\mathbf{f}}_R$
$\int$
$^B\dot{\mathbf{f}}_R$
$\int$
$^B\mathbf{f}_R$
Dynamic System
Outputs & Derivativ.
$\mathbf{x}$

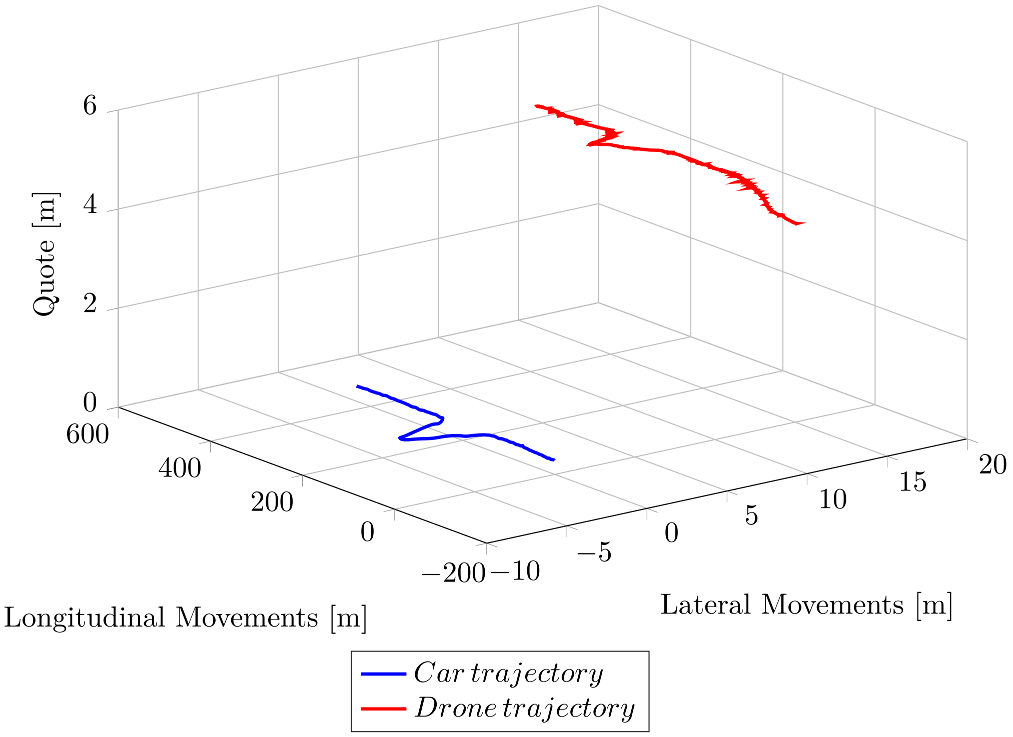
1.35 Example 35


Gazebo
State Observer
$^{W}\mathbf{r}_B$
$\boldsymbol{\vartheta}$
Odometry Sensor
$\hat{\boldsymbol{\varphi}}$, $\dot{\hat{\boldsymbol{\varphi}}}$
$\hat{\boldsymbol{\vartheta}}$, $\dot{\hat{\boldsymbol{\vartheta}}}$
PD Controller
$^{B}\bar{\boldsymbol{\tau}}_R$
$^{B}\bar{\mathbf{f}}_R$
Gazebo
Trajectory Generator
$\boldsymbol{\varphi}^d, \ldots,$
$\boldsymbol{\varphi}^{(4)d}$
$^{B}\mathbf{f}_L^d,$
$^{B}\mathbf{f}_L^{(1)d},$
$^{B}\mathbf{f}_L^{(2)d}$
A
$\bar{A}$
$\bar{A}$
Syst. & Rot. Dynamics
Feed. Linea. Controller
$^{B}\boldsymbol{\tau}_R$
$^{B}\mathbf{f}_R$
$\hat{\boldsymbol{\varphi}}$, $\dot{\hat{\boldsymbol{\varphi}}}$
$\hat{\boldsymbol{\vartheta}}$, $\dot{\hat{\boldsymbol{\vartheta}}}$
Gazebo
State Observer
$^{W}\mathbf{r}_B$
$\boldsymbol{\vartheta}$
Odometry Sensor

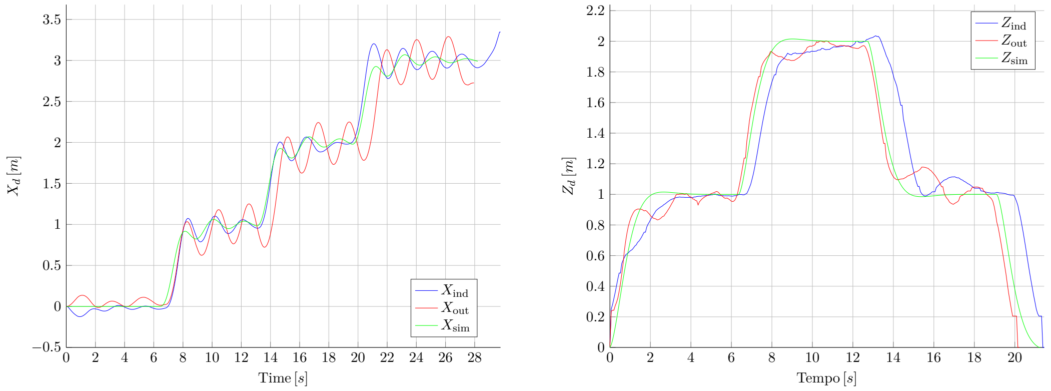
Chapter 2

Matlab Plots

2.1 Example 1

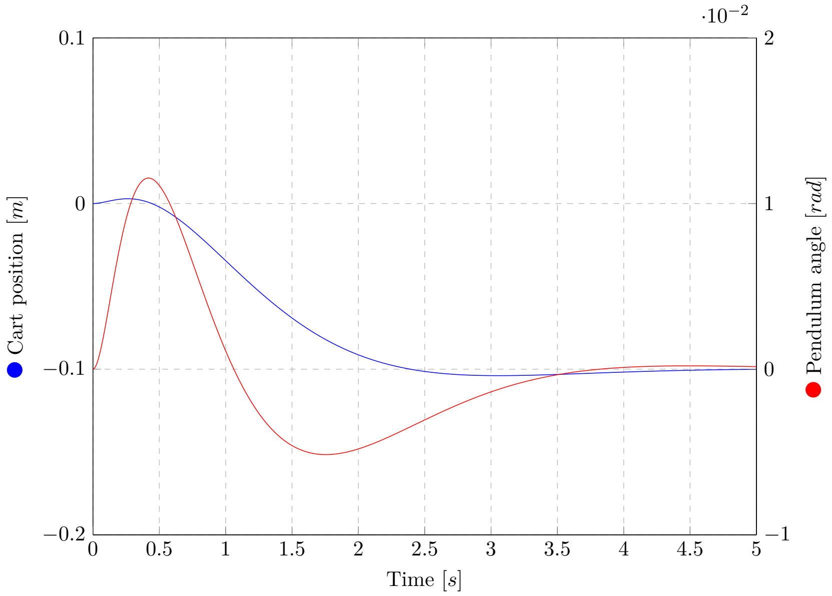


2.2 Example 2

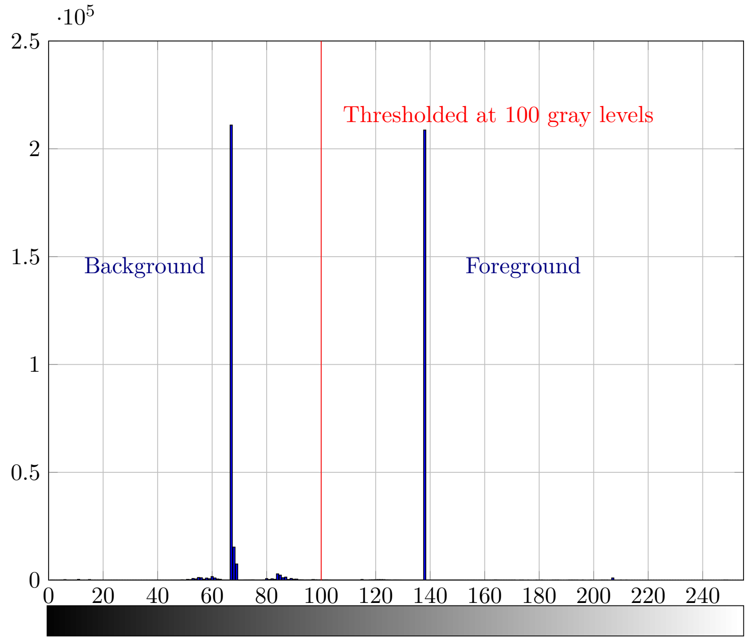


(a) (b)

2.3 Example 3



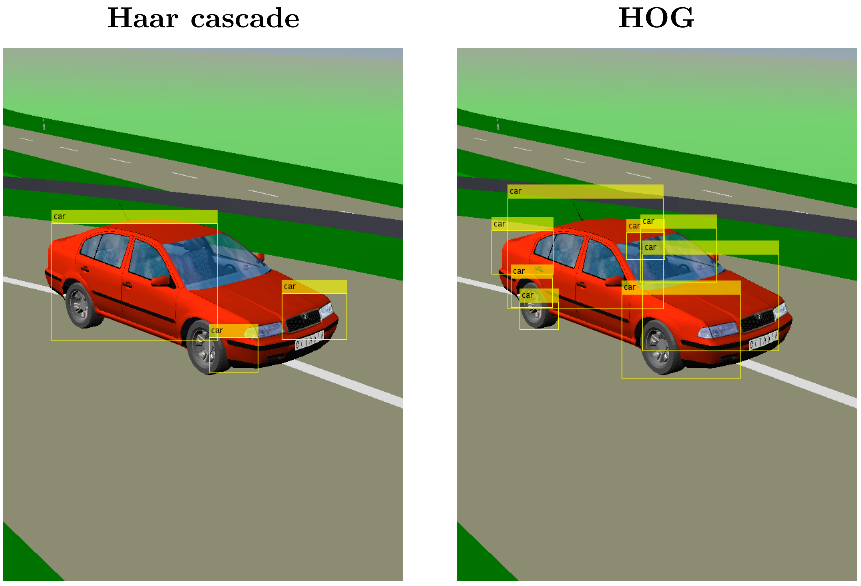
2.4 Example 4


·10^5
2.5
2
1.5
1
0.5
0
Thresholded at 100 gray levels
Background
Foreground
0
20
40
60
80
100
120
140
160
180
200
220
240

Chapter 3

Drawing on Images

3.1 Example 1

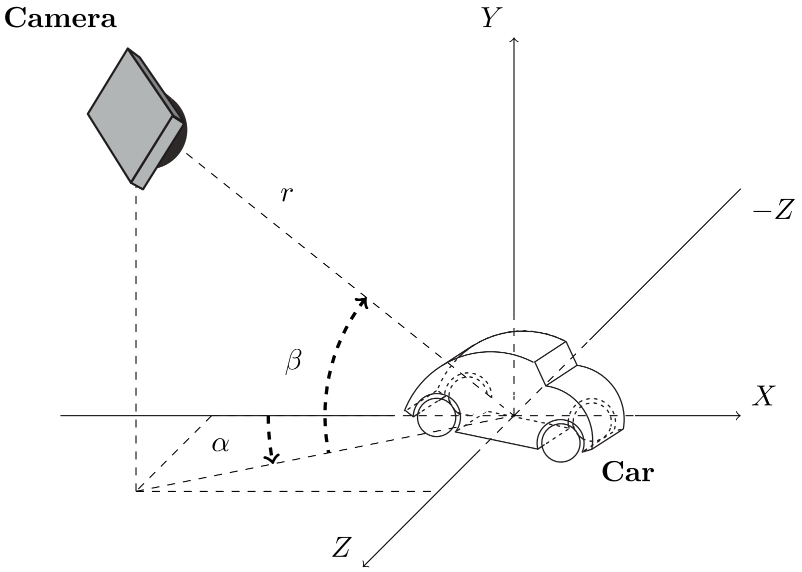


Haar cascade

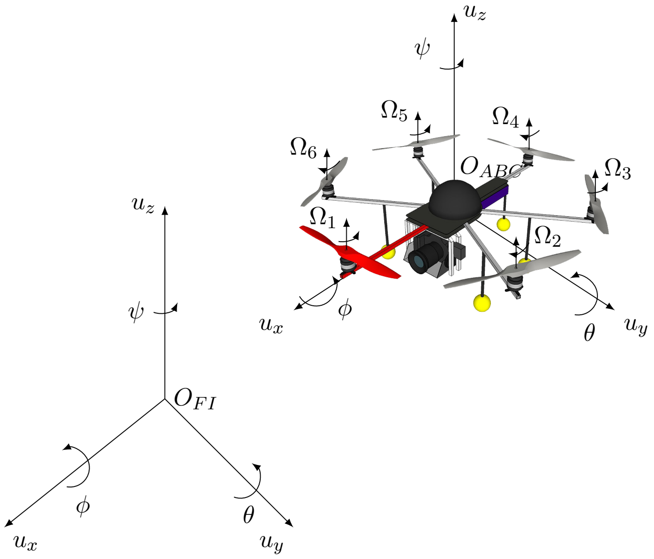
HOG

car
car
car
car
car
car
car
car
car
car
car

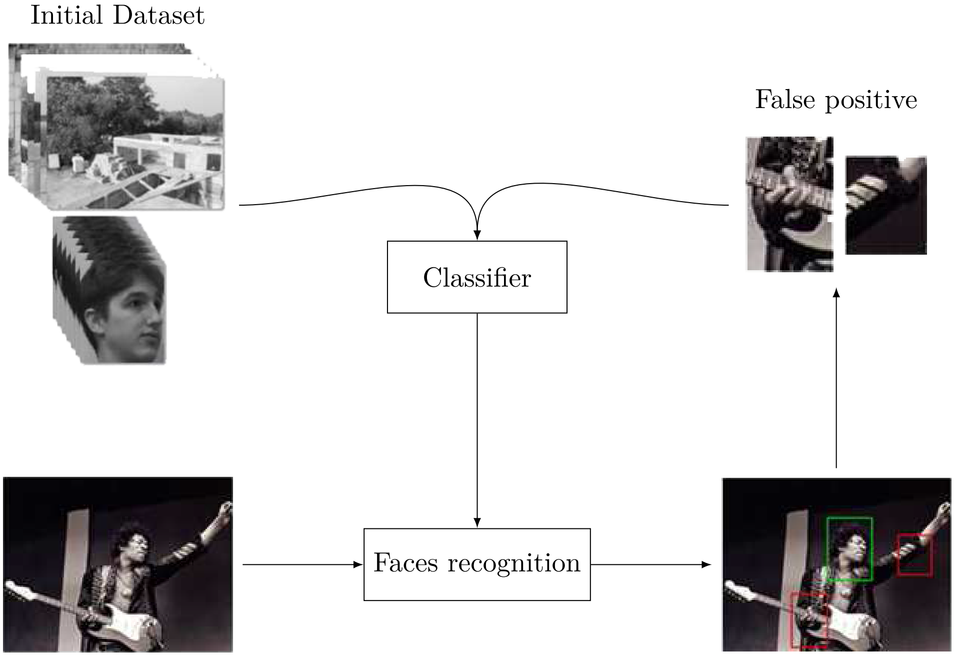
3.2 Example 2


Camera
Y
r
$-Z$
β
X
α
Car
Z

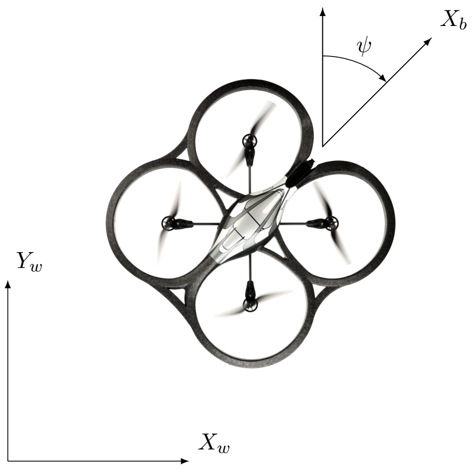
3.3 Example 3


u_z
ψ
Ω_5
Ω_4
Ω_6
O_{ABC}
Ω_3
Ω_1
Ω_2
u_x
ϕ
θ
u_y
u_z
ψ
O_{FI}
ϕ
θ
u_x
u_y

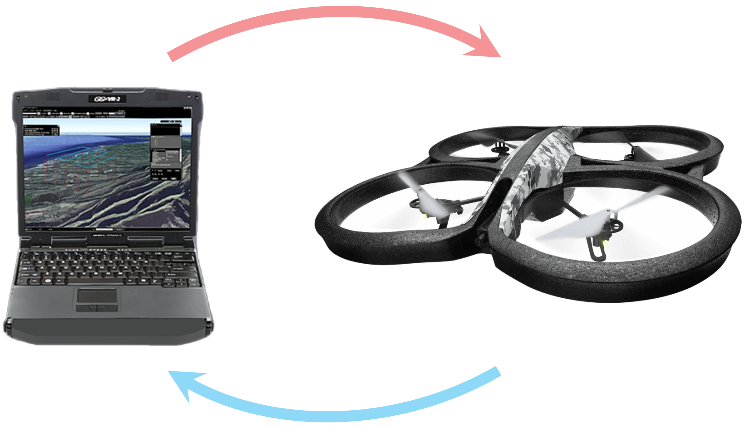
3.4 Example 4


Initial Dataset
False positive
Classifier
Faces recognition

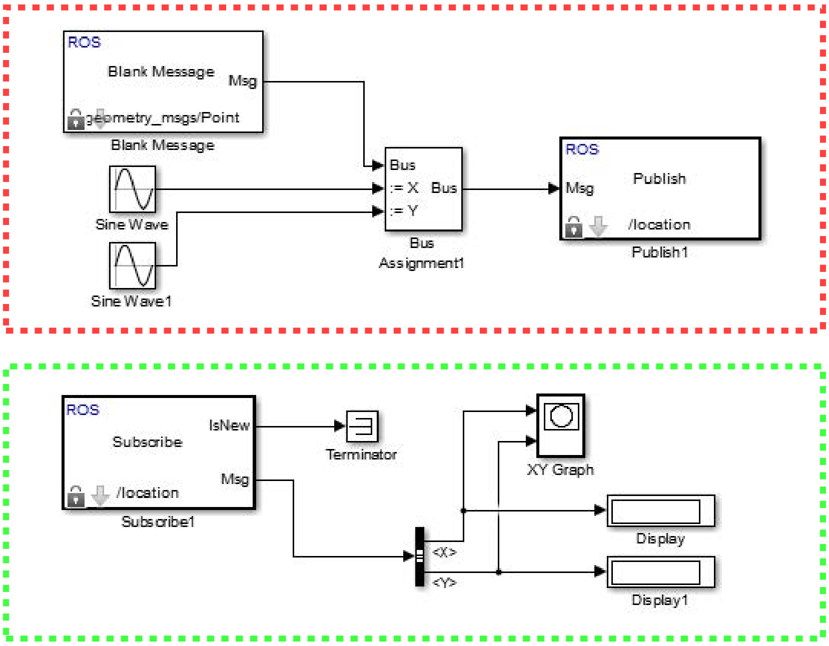
3.5 Example 5



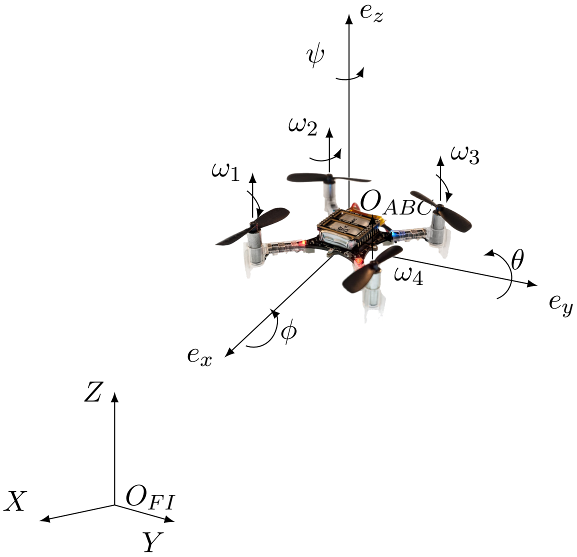
3.6 Example 6



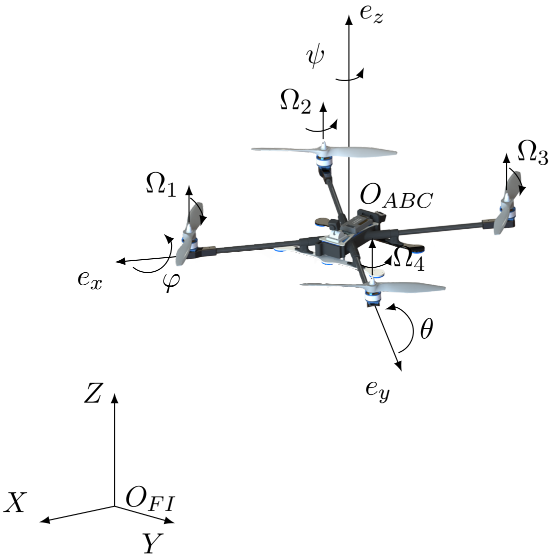
3.7 Example 7


ROS
Blank Message
Msg
geometry_msgs/Point
Blank Message
Sine Wave
Sine Wave1
Bus
:= X
Bus
:= Y
Bus Assignment1
ROS
Msg
Publish
/location
Publish1
ROS
IsNew
Subscribe
Msg
/location
Subscribe1
Terminator
XY Graph
<X>
<Y>
Display
Display1

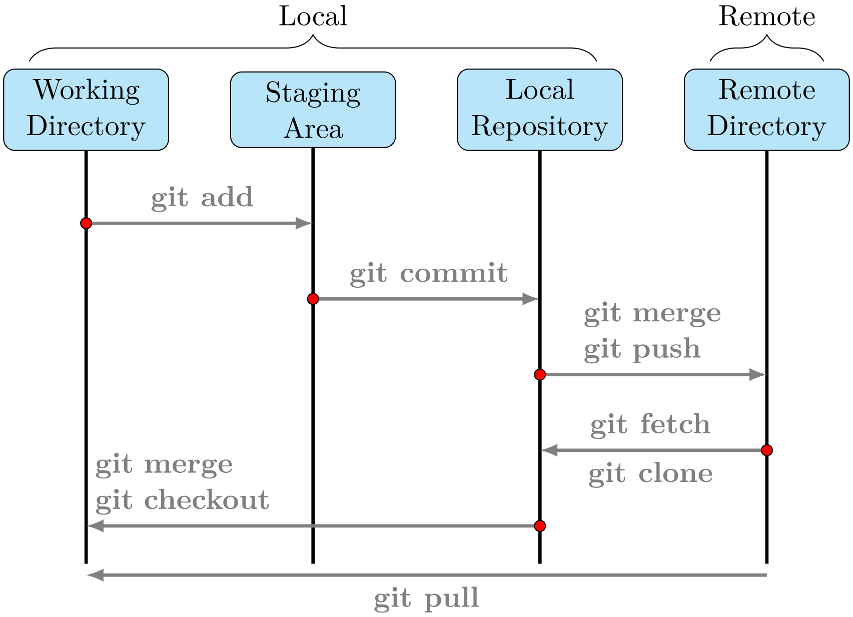
3.8 Example 8


e_z
ψ
ω_2
ω_3
ω_1
O_{ABC}
θ
ω_4
e_y
ϕ
e_x
Z
X
O_{FI}
Y

3.9 Example 9


e_z
ψ
Ω_2
Ω_3
Ω_1
O_{ABC}
Ω_4
e_x
φ
θ
e_y
Z
X
O_{FI}
Y

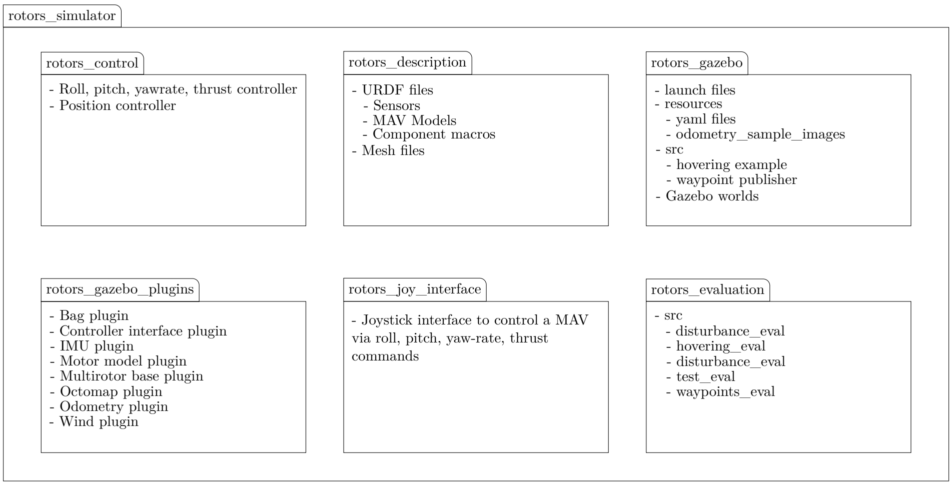
3.10 Example 10


Local
Remote
Working Directory
Staging Area
Local Repository
Remote Directory
git add
git commit
git merge
git push
git fetch
git clone
git merge
git checkout
git pull

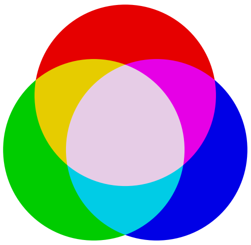
Chapter 4

Various

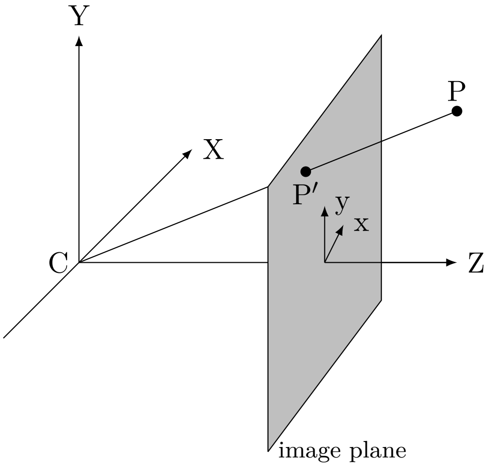
4.1 Example 1


rotors_simulator
rotors_control
- Roll, pitch, yawrate, thrust controller
- Position controller
rotors_description
- URDF files
- Sensors
- MAV Models
- Component macros
- Mesh files
rotors_gazebo
- launch files
- resources
- yaml files
- odometry_sample_images
- src
- hovering example
- waypoint publisher
- Gazebo worlds
rotors_gazebo_plugins
- Bag plugin
- Controller interface plugin
- IMU plugin
- Motor model plugin
- Multirotor base plugin
- Octomap plugin
- Odometry plugin
- Wind plugin
rotors_joy_interface
- Joystick interface to control a MAV via roll, pitch, yaw-rate, thrust commands
rotors_evaluation
- src
- disturbance_eval
- hovering_eval
- disturbance_eval
- test_eval
- waypoints_eval

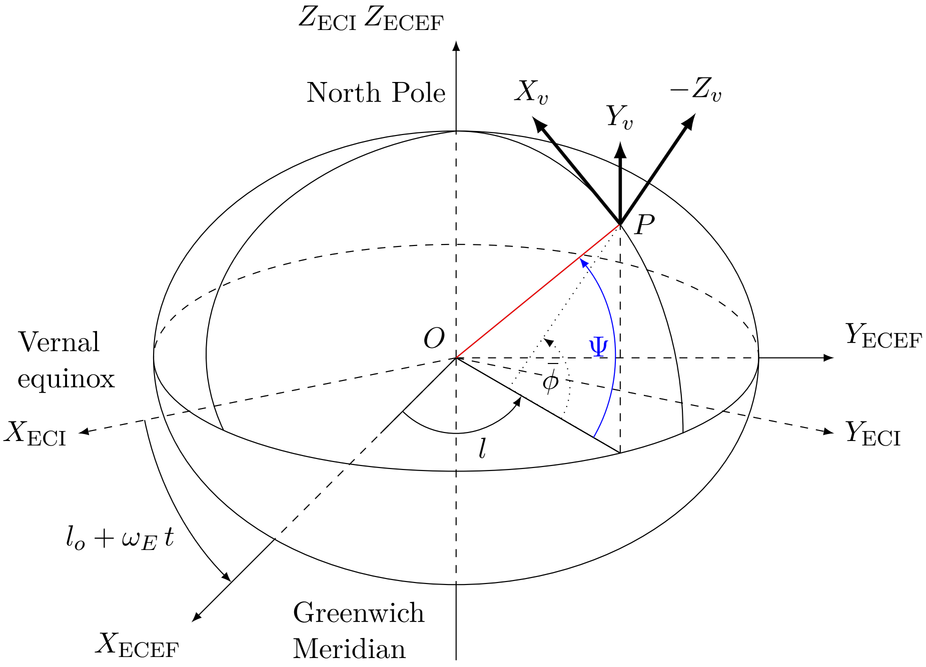
4.2 Example 2



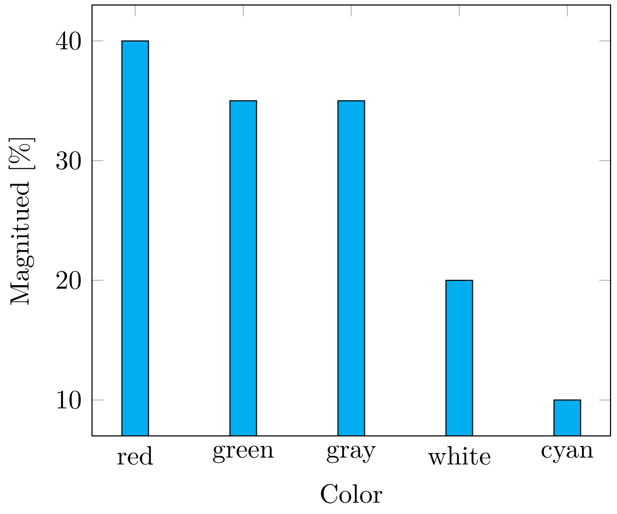
4.3 Example 3


Y
X
P
P′
y
x
C
Z
image plane

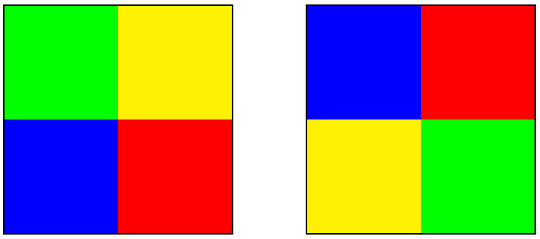
4.4 Example 4


Z_{ECI} Z_{ECEF}
North Pole
X_v
Y_v
$-Z_v$
P
O
Ψ
ϕ
Y_{ECEF}
Vernal equinox
X_{ECI}
Y_{ECI}
l
$l_o + \omega_E t$
X_{ECEF}
Greenwich Meridian

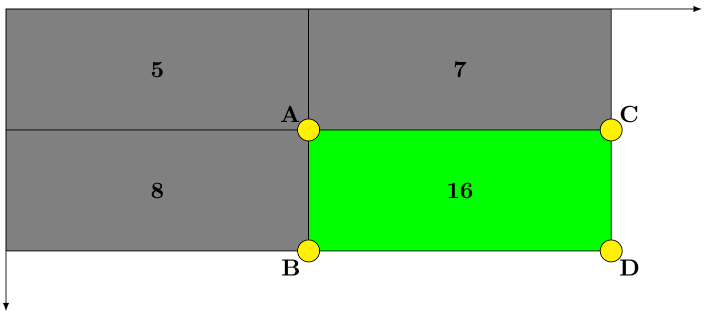
4.5 Example 5



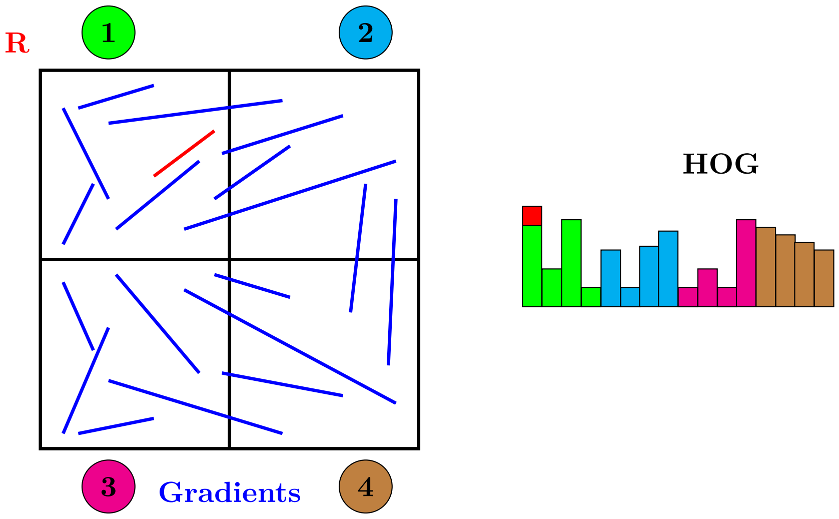
4.6 Example 6



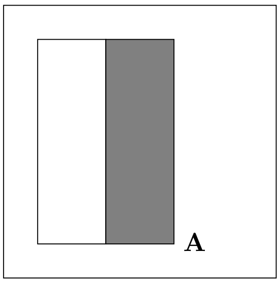
4.7 Example 7

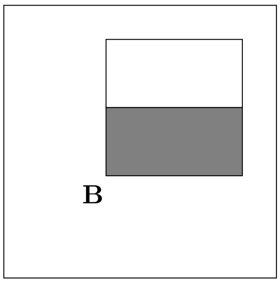


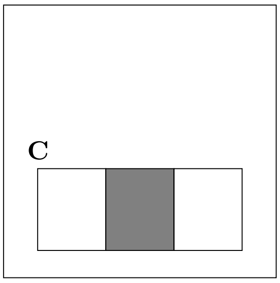
4.8 Example 8

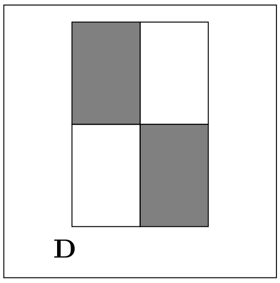

R
1
2
HOG
3
Gradients
4

4.9 Example 9

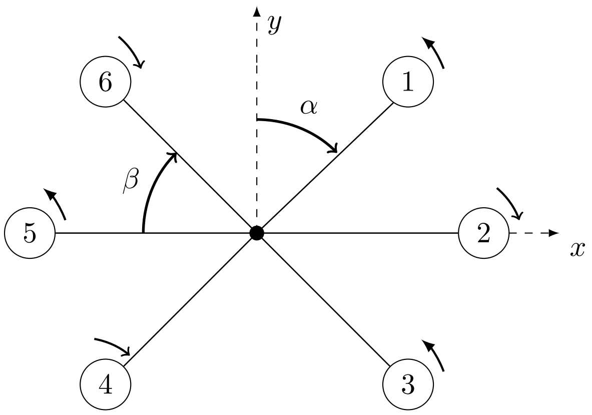




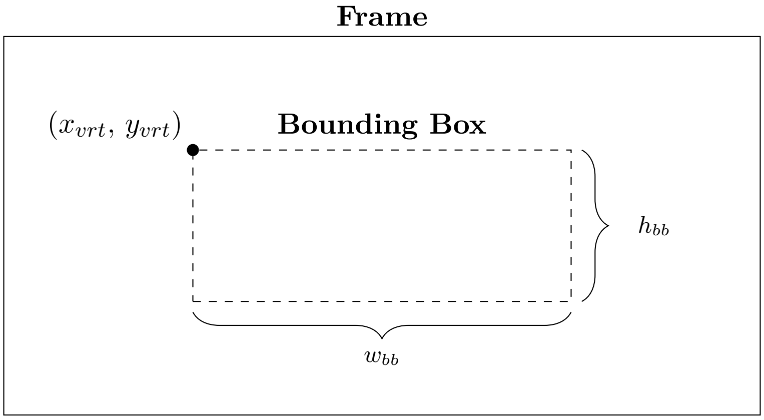




4.10 Example 10


y
x
α
β
1
2
3
4
5
6

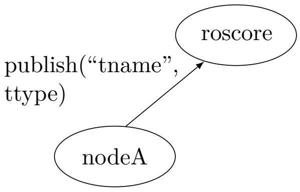
4.11 Example 11

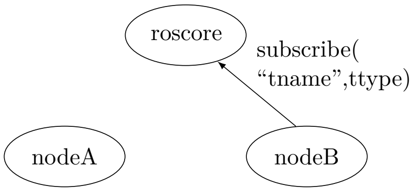

Frame
(x_{vrt}, y_{vrt})
Bounding Box
h_{bb}
w_{bb}

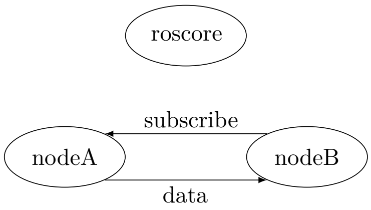
4.12 Example 12

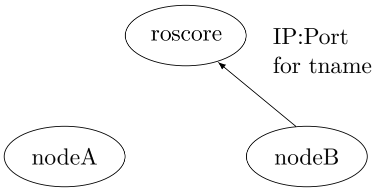
0	1	2	3	4	5	6 to n+6	n+7	n+8
str	lgt	seq	cmp	sys	msg	dat	cks	cks

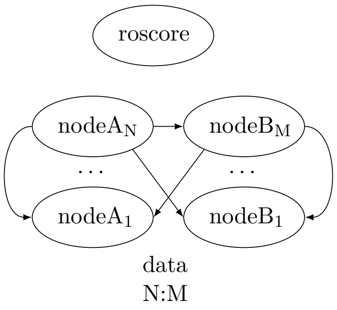
4.13 Example 13


roscore
publish("tname",
ttype)
nodeA

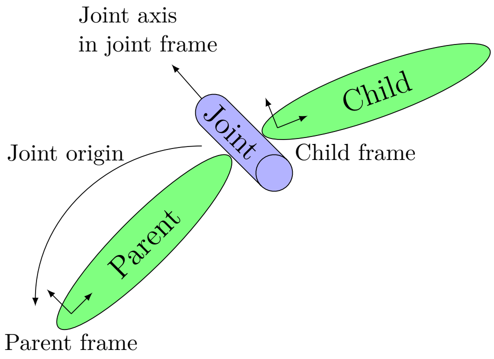

roscore
subscribe(
"tname",ttype)
nodeA
nodeB


roscore
subscribe
nodeA
nodeB
data

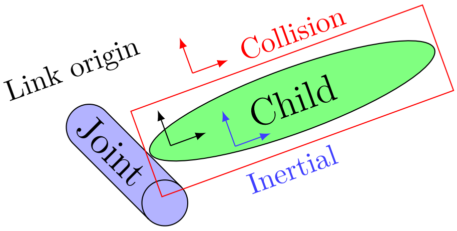

roscore
IP:Port
for tname
nodeA
nodeB


roscore
nodeA_N
nodeB_M
...
...
nodeA_1
nodeB_1
data
N:M

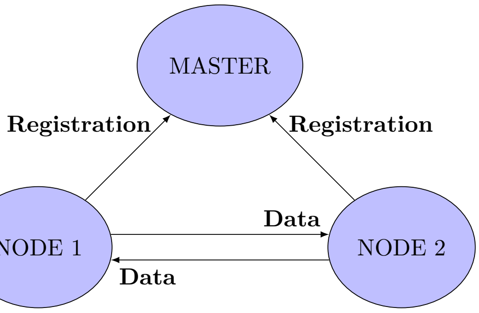
4.14 Example 14


Joint axis
in joint frame
Child
Joint
Joint origin
Child frame
Parent
Parent frame

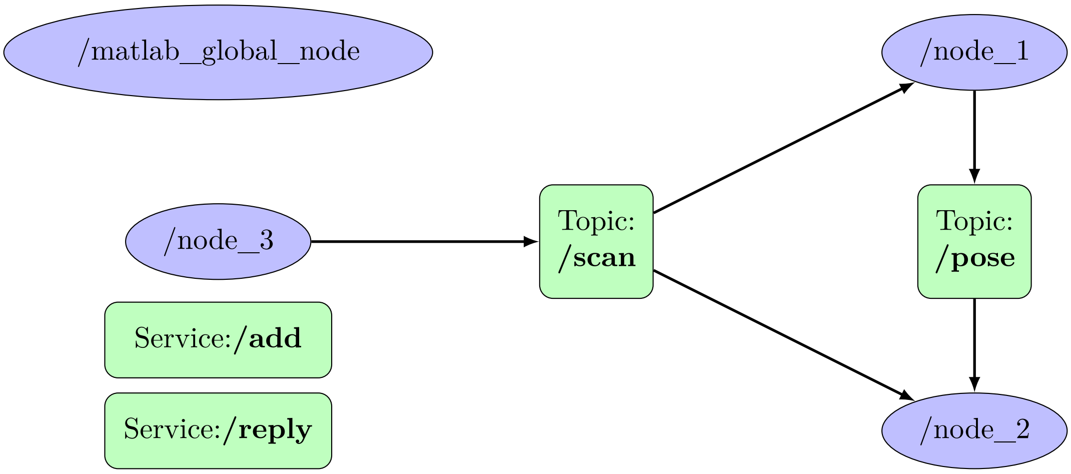
4.15 Example 15


Link origin
Collision
Child
Joint
Inertial

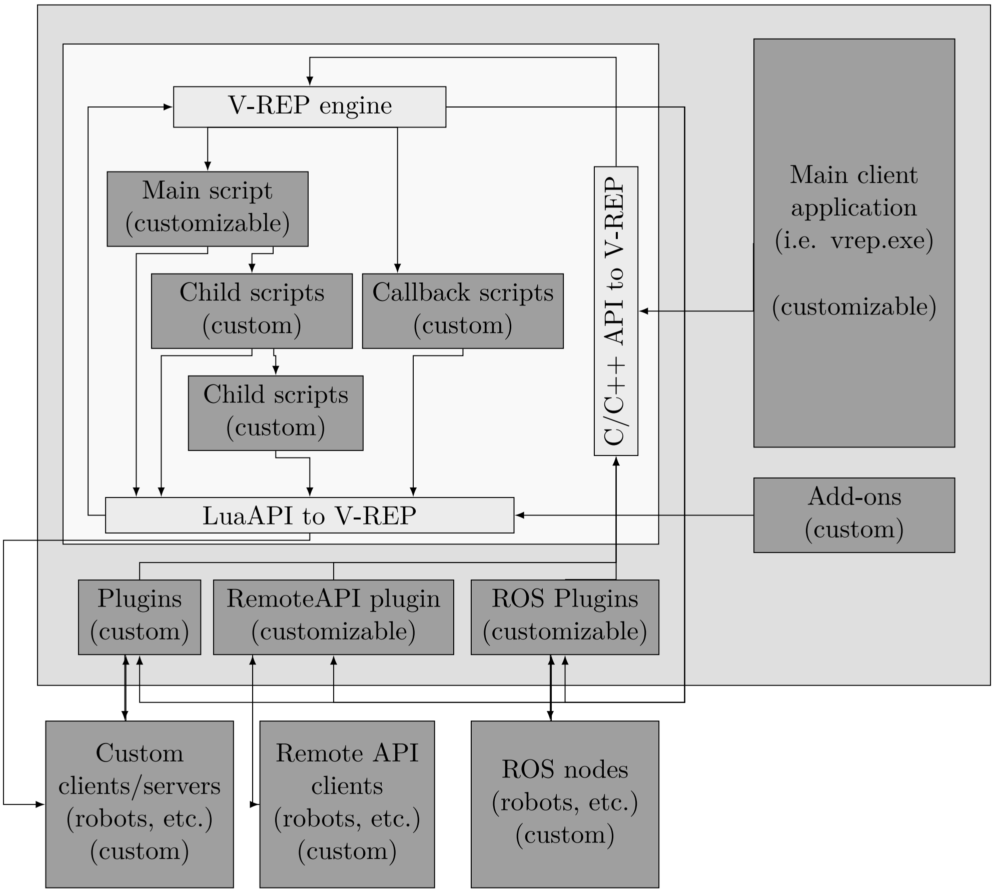
4.16 Example 16


MASTER
Registration
Registration
NODE 1
Data
NODE 2
Data

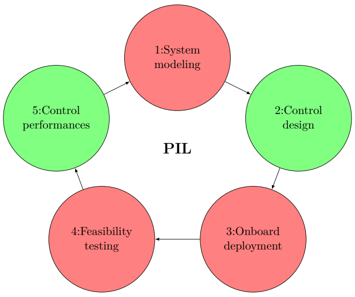
4.17 Example 17

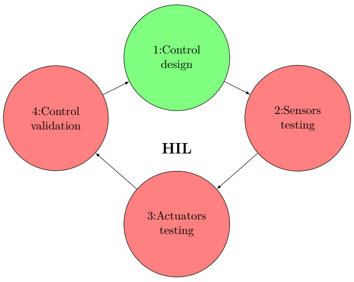

/matlab_global_node
/node_1
/node_3
Topic:
/scan
Topic:
/pose
Service:/add
Service:/reply
/node_2

4.18 Example 18

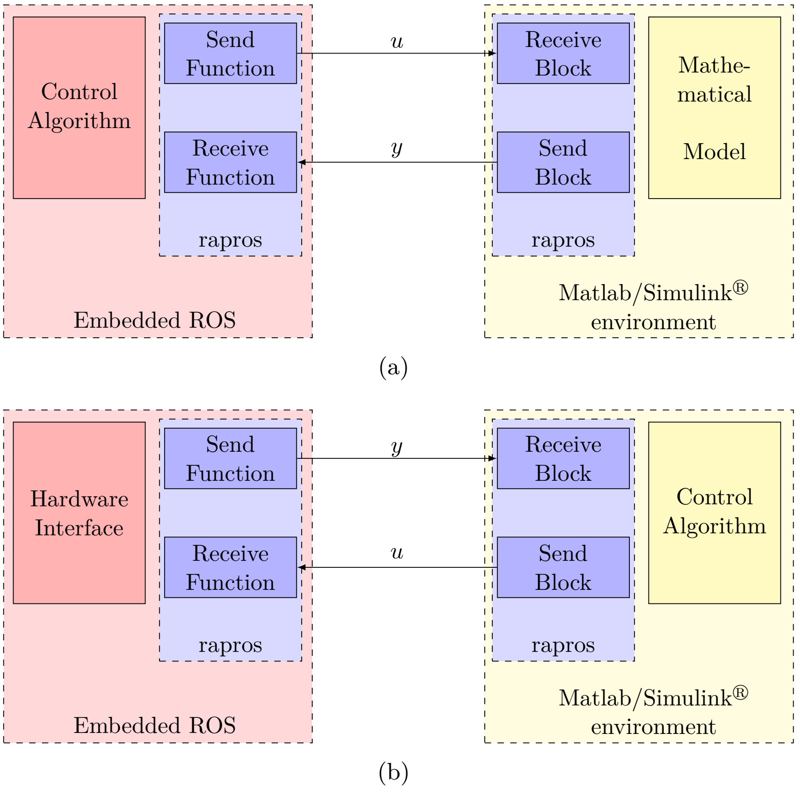

V-REP engine
Main script
(customizable)
Child scripts
(custom)
Callback scripts
(custom)
Child scripts
(custom)
C/C++ API to V-REP
LuaAPI to V-REP
Main client
application
(i.e. vrep.exe)
(customizable)
Add-ons
(custom)
Plugins
(custom)
RemoteAPI plugin
(customizable)
ROS Plugins
(customizable)
Custom
clients/servers
(robots, etc.)
(custom)
Remote API
clients
(robots, etc.)
(custom)
ROS nodes
(robots, etc.)
(custom)

4.19 Example 19


1:System
modeling
2:Control
design
3:Onboard
deployment
4:Feasibility
testing
5:Control
performances
PIL


1:Control
design
2:Sensors
testing
3:Actuators
testing
4:Control
validation
HIL

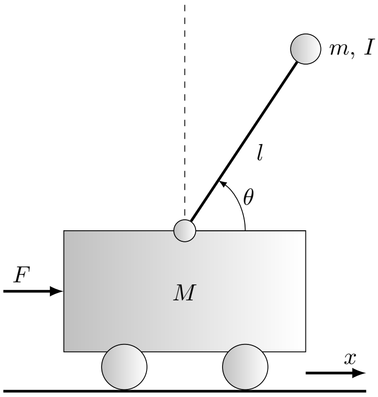
4.20 Example 20


Control
Algorithm
Send
Function
Receive
Function
rapros
Embedded ROS
u
y
Receive
Block
Send
Block
rapros
Mathe-
matical
Model
Matlab/Simulink®
environment
Hardware
Interface
Send
Function
Receive
Function
rapros
Embedded ROS
y
u
Receive
Block
Send
Block
rapros
Control
Algorithm
Matlab/Simulink®
environment

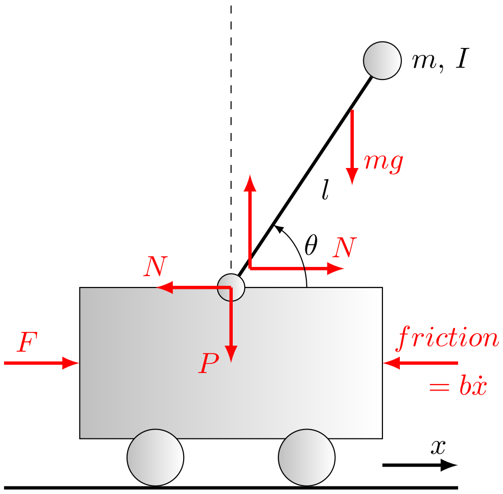
(a)

(b)

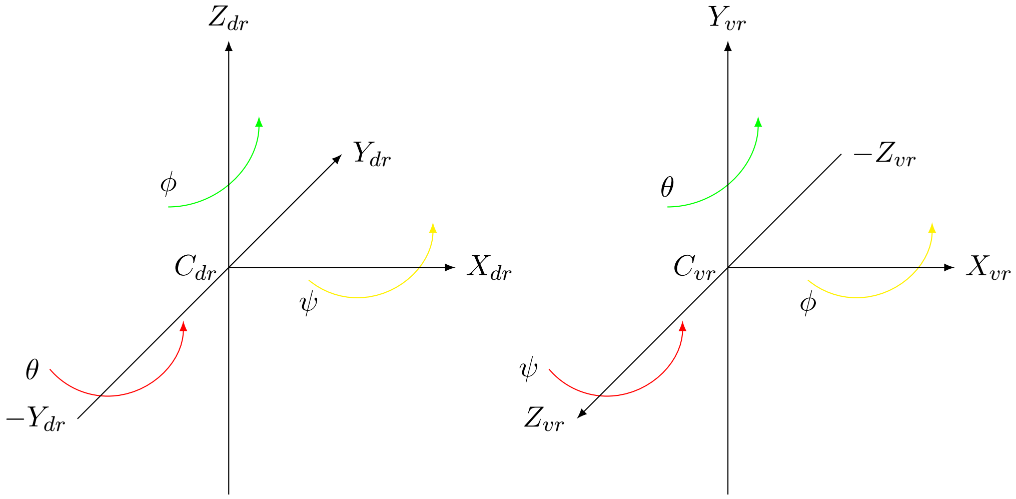
4.21 Example 21



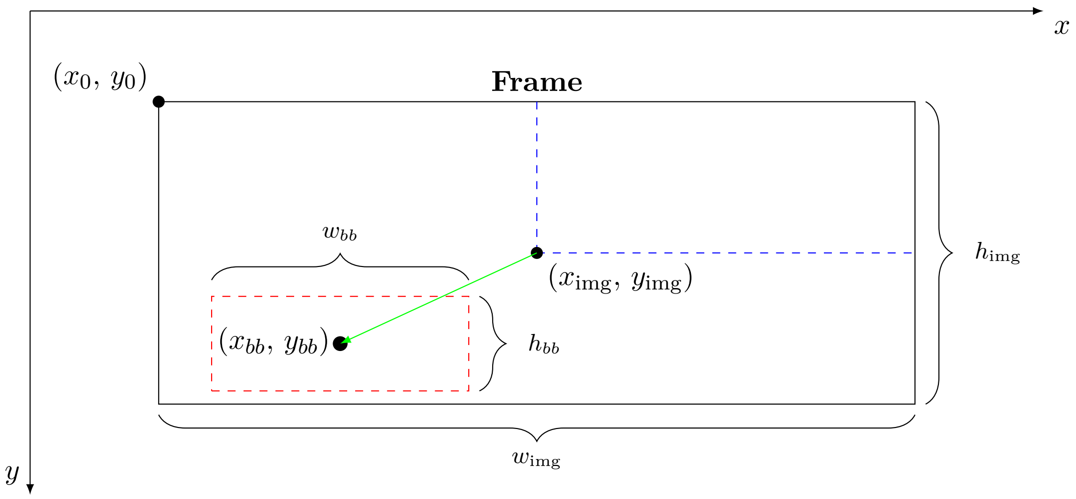
4.22 Example 22


m, I
mg
l
θ
N
N
F
P
$friction$
$= b\dot{x}$
x

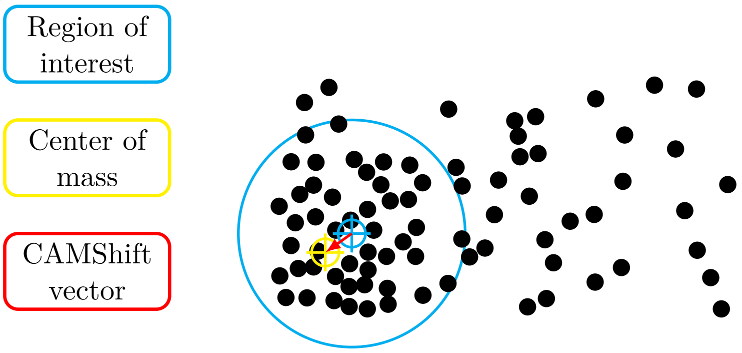
4.23 Example 23


Z_{dr}
Y_{dr}
ϕ
C_{dr}
X_{dr}
ψ
θ
$-Y_{dr}$
Y_{vr}
$-Z_{vr}$
θ
C_{vr}
X_{vr}
ϕ
ψ
Z_{vr}

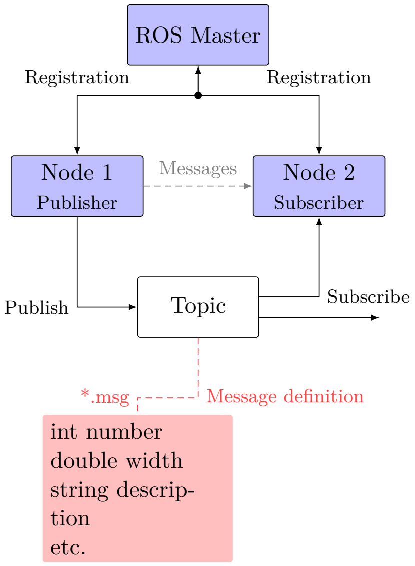
4.24 Example 24


x
(x_0, y_0)
Frame
w_{bb}
$(x_{\text{img}}, y_{\text{img}})$
h_{img}
(x_{bb}, y_{bb})
h_{bb}
w_{img}
y

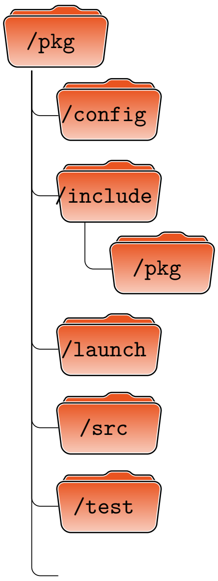
4.25 Example 25


Region of interest
Center of mass
CAMShift vector

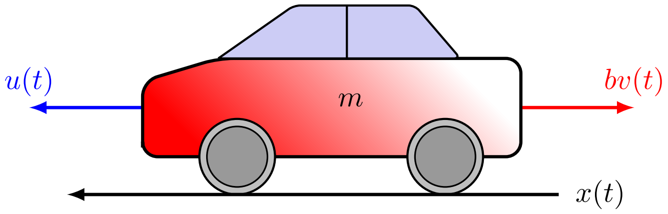
4.26 Example 26


ROS Master
Registration
Registration
Node 1
Publisher
Messages
Node 2
Subscriber
Publish
Topic
Subscribe
*.msg
Message definition
int number
double width
string description
etc.

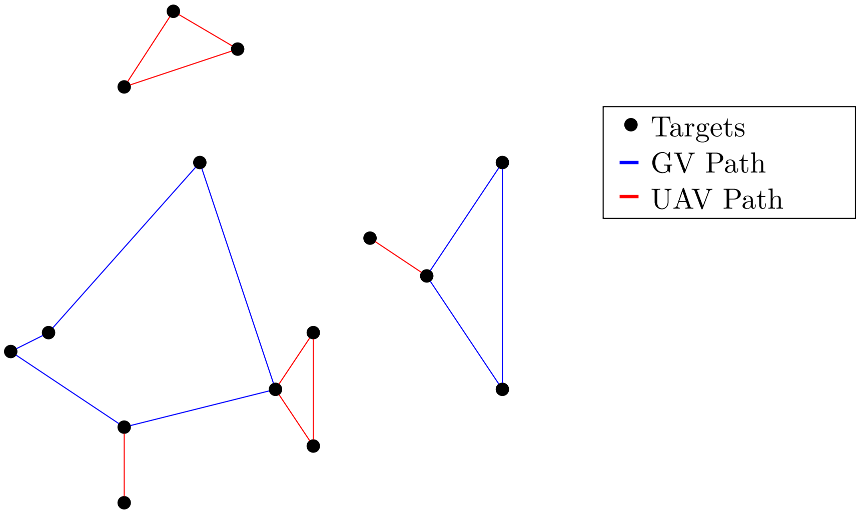
4.27 Example 27


/pkg
/config
/include
/pkg
/launch
/src
/test

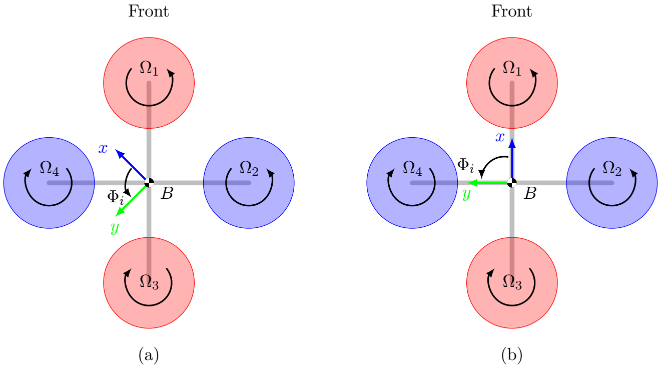
4.28 Example 28



4.29 Example 29

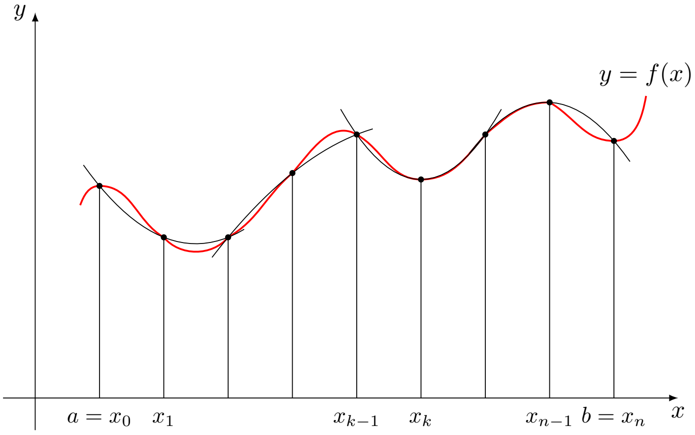

Targets
GV Path
UAV Path

4.30 Example 30


Front
Ω_1
Ω_2
Ω_3
Ω_4
x
y
Φ_i
B
Front
Ω_1
Ω_2
Ω_3
Ω_4
x
y
Φ_i
B

(a) (b)

4.31 Example 36


y
$y = f(x)$
x
$a = x_0$
x_1
x_{k-1}
x_k
x_{n-1}
$b = x_n$