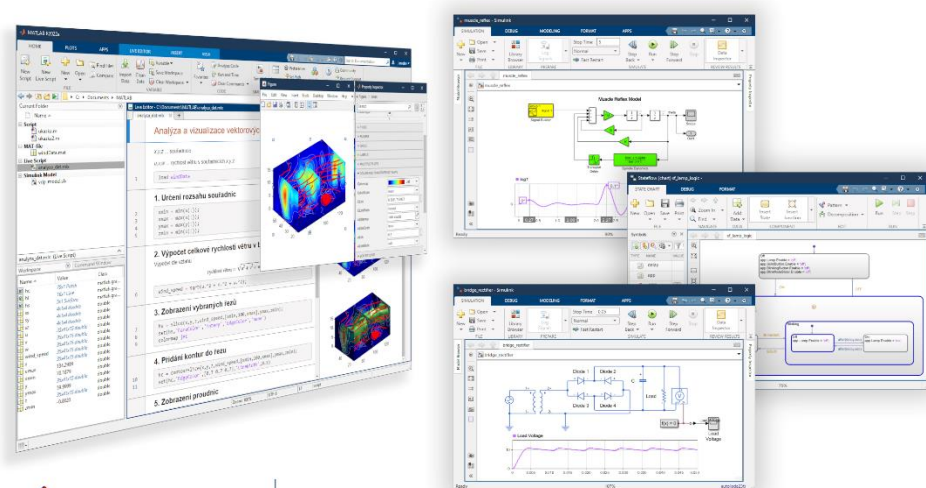


## Umelá inteligencia v autonómnych systémoch

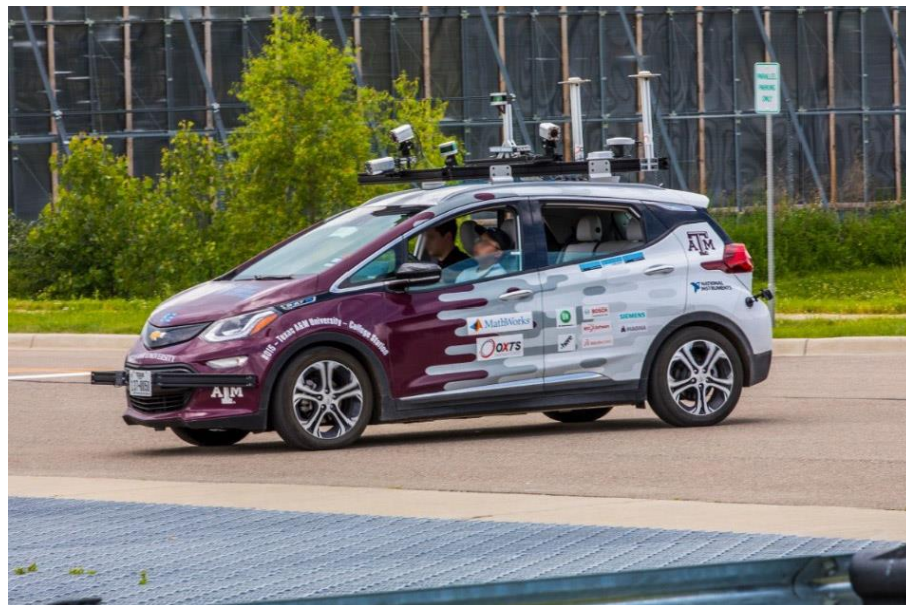


Michal Blaho  
[blaho@humusoft.sk](mailto:blaho@humusoft.sk)

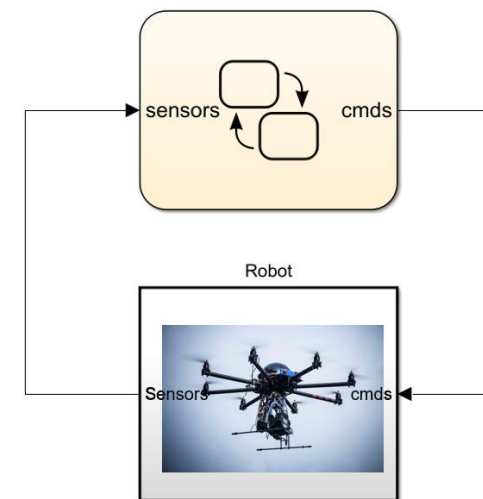
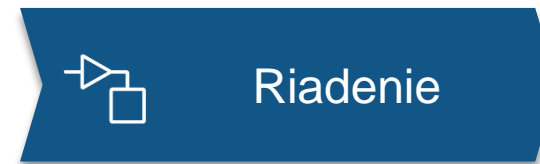
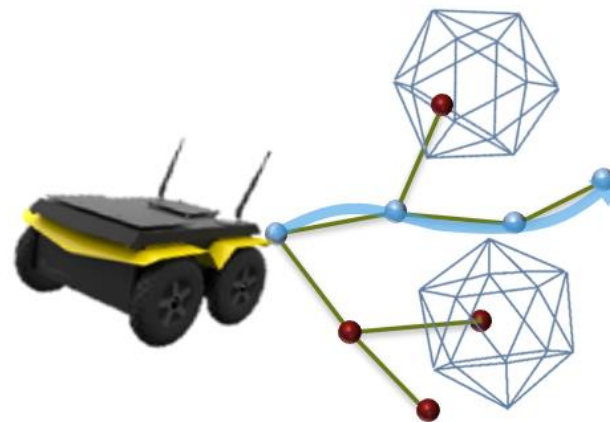
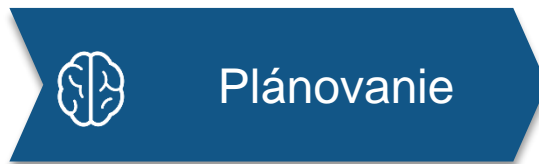
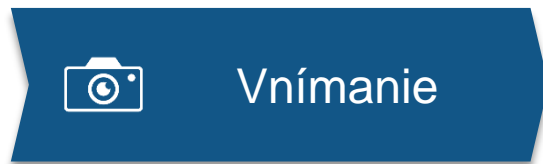
[www.humusoft.cz](http://www.humusoft.cz)  
[info@humusoft.cz](mailto:info@humusoft.cz)

[www.mathworks.com](http://www.mathworks.com)

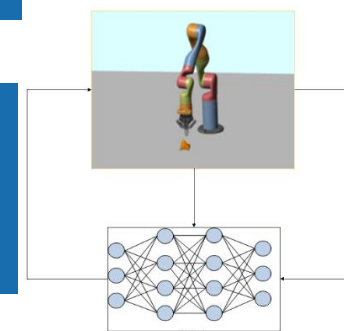
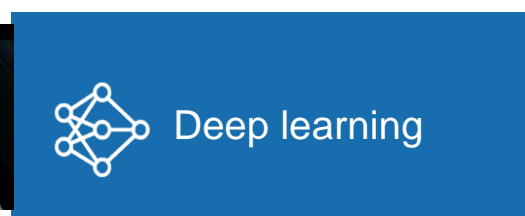
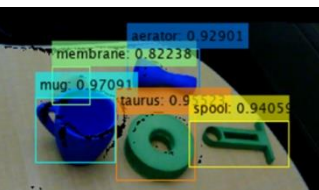
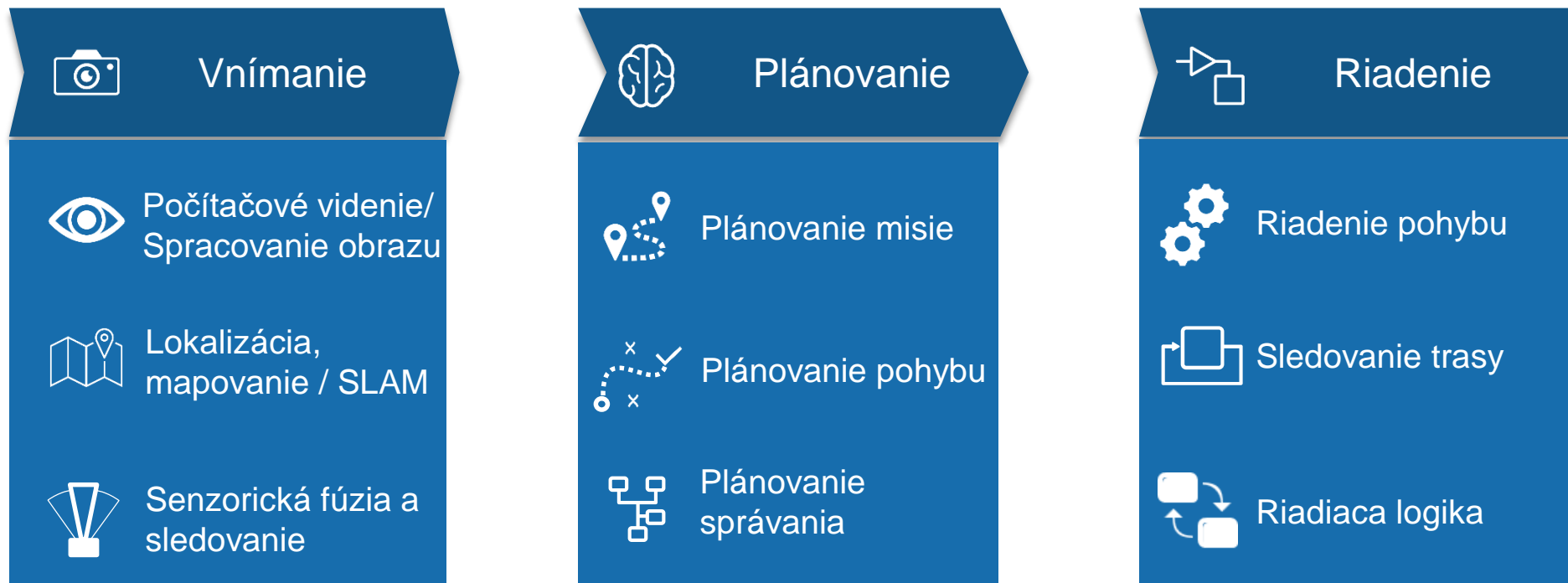
# Autonómne systémy



# Hlavné súčasti autonómnych systémov



# Hlavné súčasti autonómnych systémov



# Hlavné súčasti autonómnych systémov



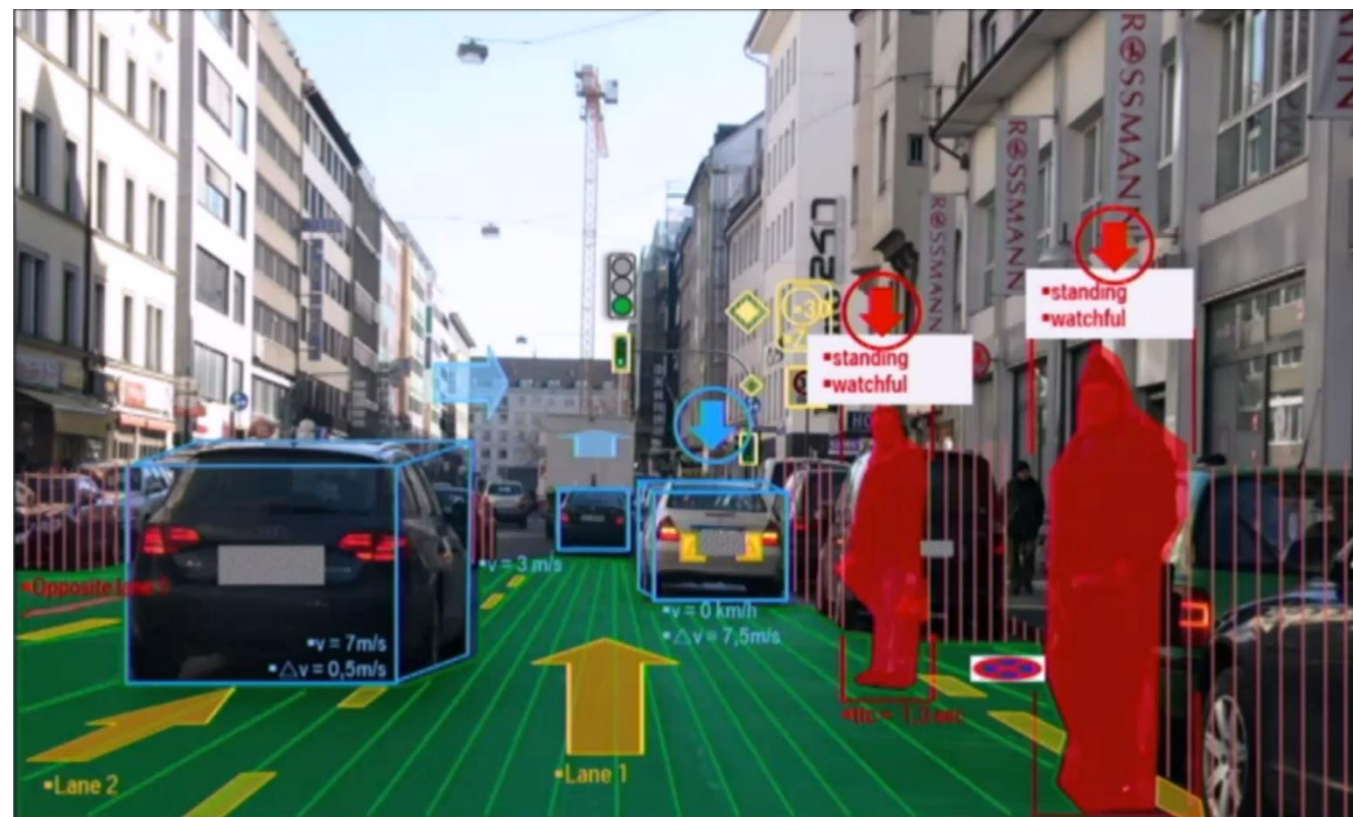
Vnímanie





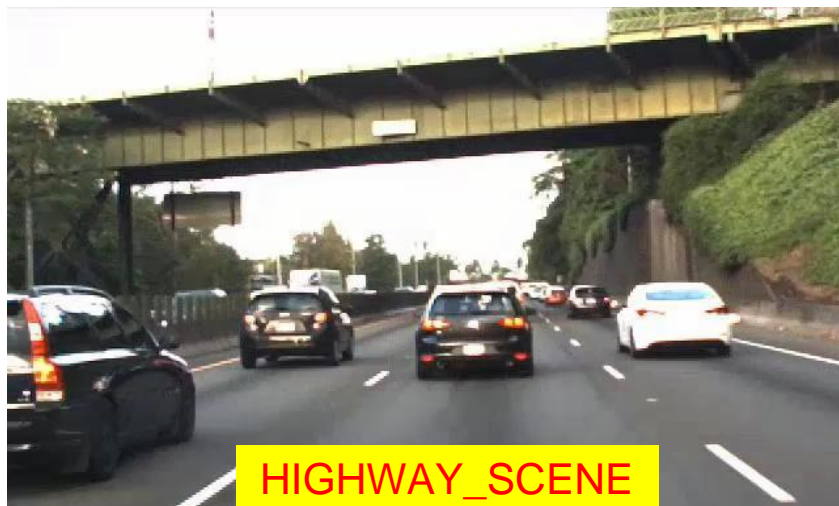
# Komplexné vnímanie pomocou AI

- Jazdný pruh / cesta
- Čiary a značky na ceste
- Semafóry
- Iní účastníci
  - Vozidlá
  - Chodci
  - Bicyklisti
- Úlohy
  - Detekcia a predikcia správania



# Počítačové videnie v autonómnych systémoch

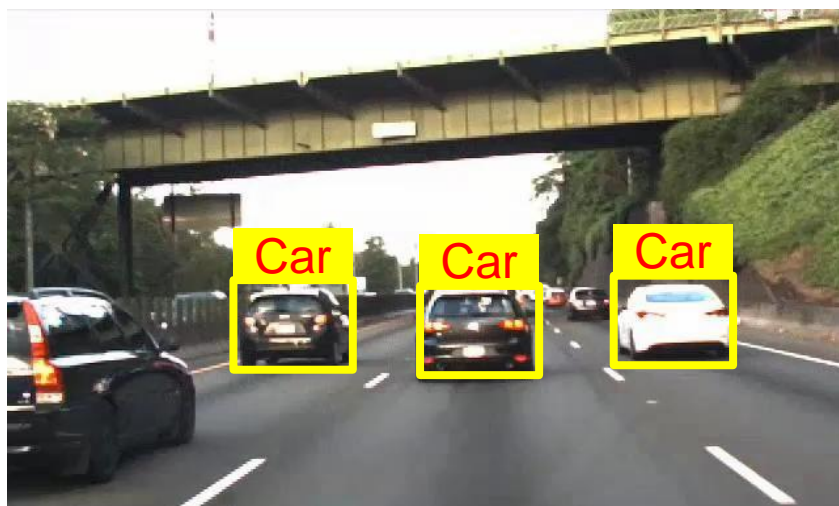
Klasifikácia



Regresia



Detekcia



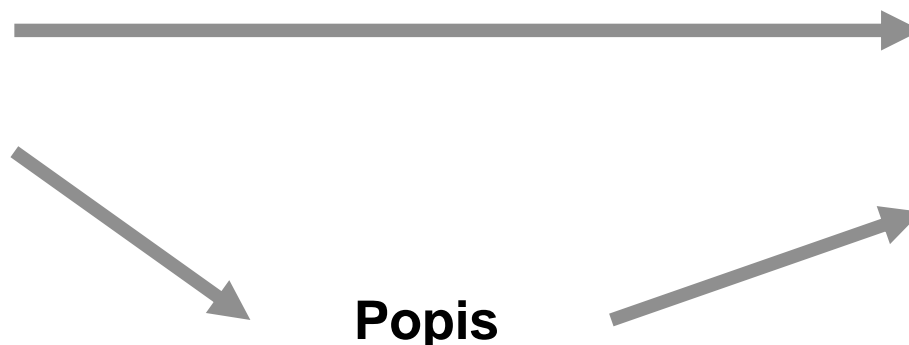
Sémantická segmentácia



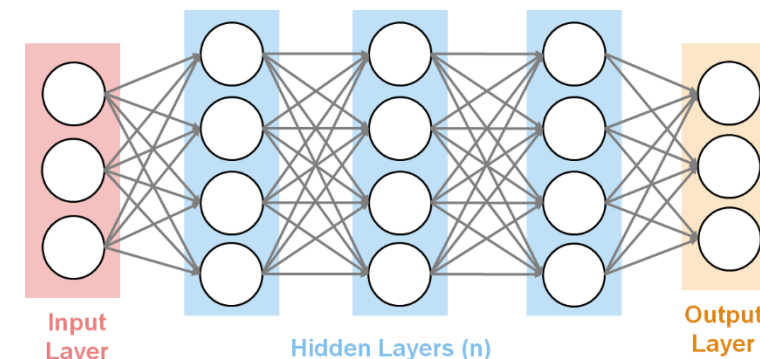
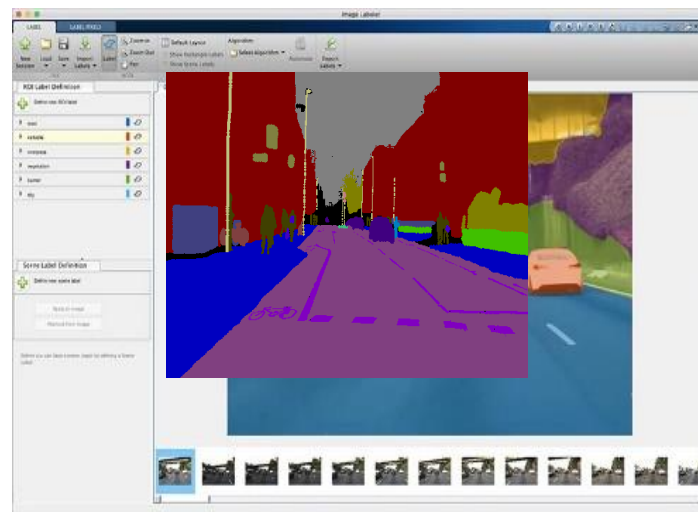
# Pracovný postup tvorby modelu AI



**Dáta**



**Popis**



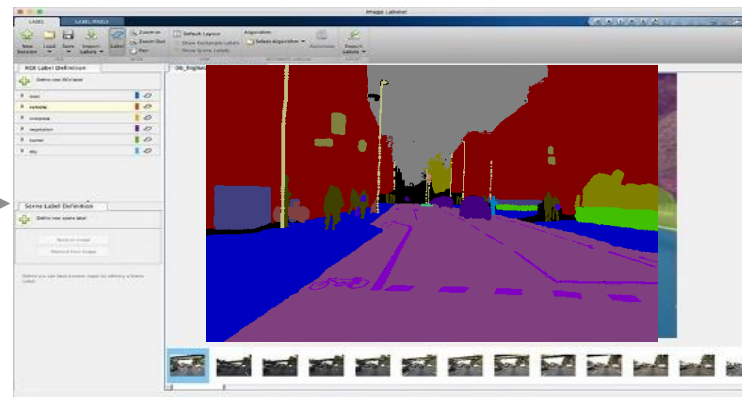
**Trénovanie  
AI modelu**



# Urýchlenie popisovania



**Dáta**



**Popis**

**Natrénovaný  
AI model**

**Trénovanie**

**Manuálne  
overenie**



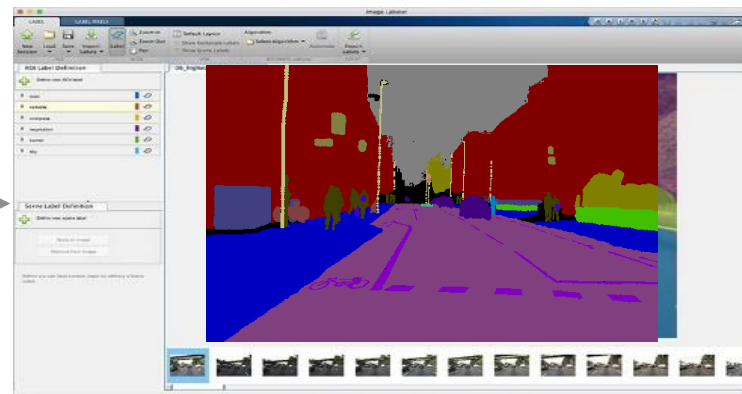
**Návrh  
popisov**

# Generovanie popísaných dát zo simulácie

## Tradičný postup DL



**Dáta**



**Popis**

**Trénovanie**

**Natrénovaný  
AI model**

## Simulation Environment



**Simulácia**

**Automatický popis**

**Trénovanie**

# Generovanie obrázkov rôzneho času dňa (GANs)



## Detaily trénovania

- 370 obrázkov
- CAMVID dataset
  - Obrázky dňa: 263
  - Obrázky súmraku: 107
- Na učenie sa nepoužívajú časové informácie



**Unsupervised Day-To-Dusk Image Translation Using UNIT**

Perform domain translation between images acquired during daytime and dusk conditions using an unsupervised image-to-image

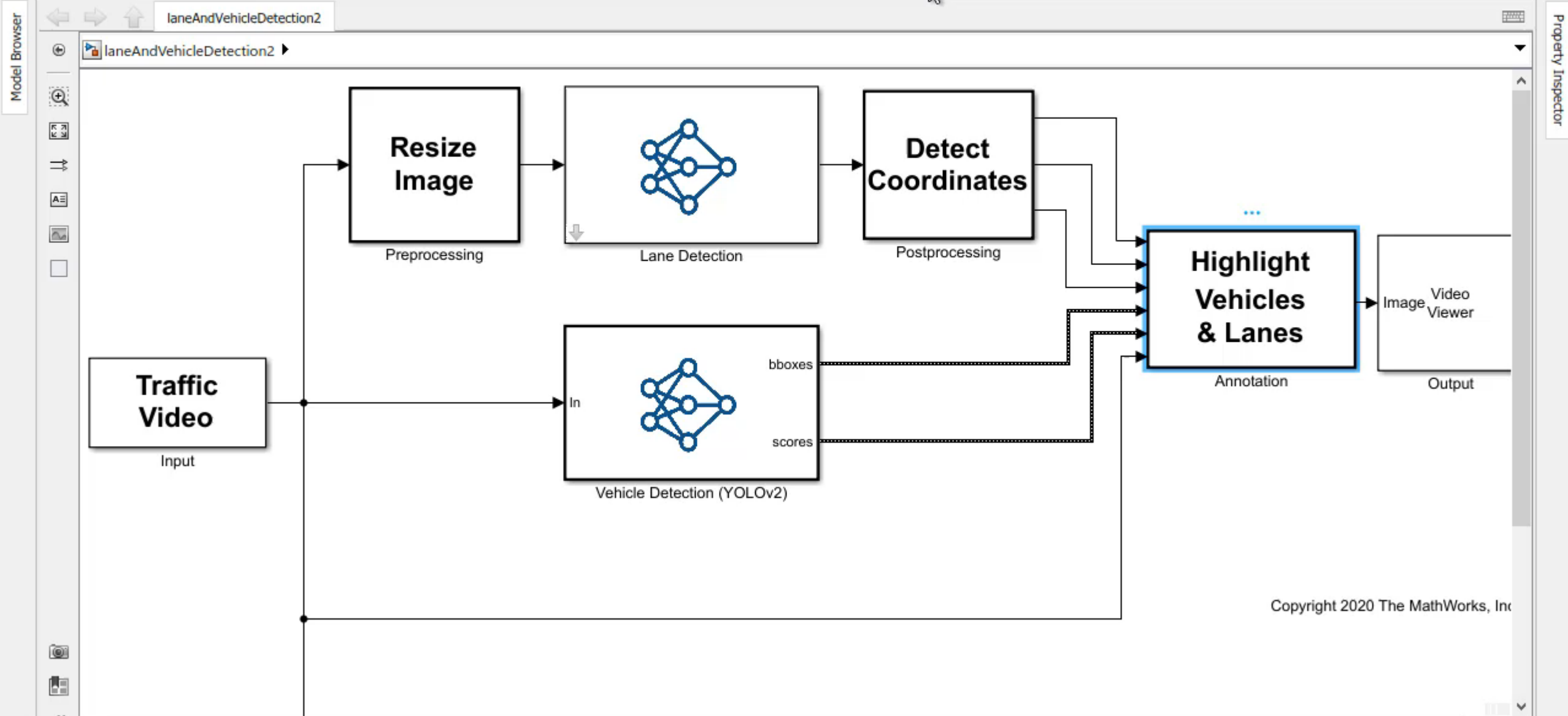
[Link to Example](#)



SIMULATION    DEBUG    MODELING    FORMAT    HARDWARE    APPS    **FUNCTION**

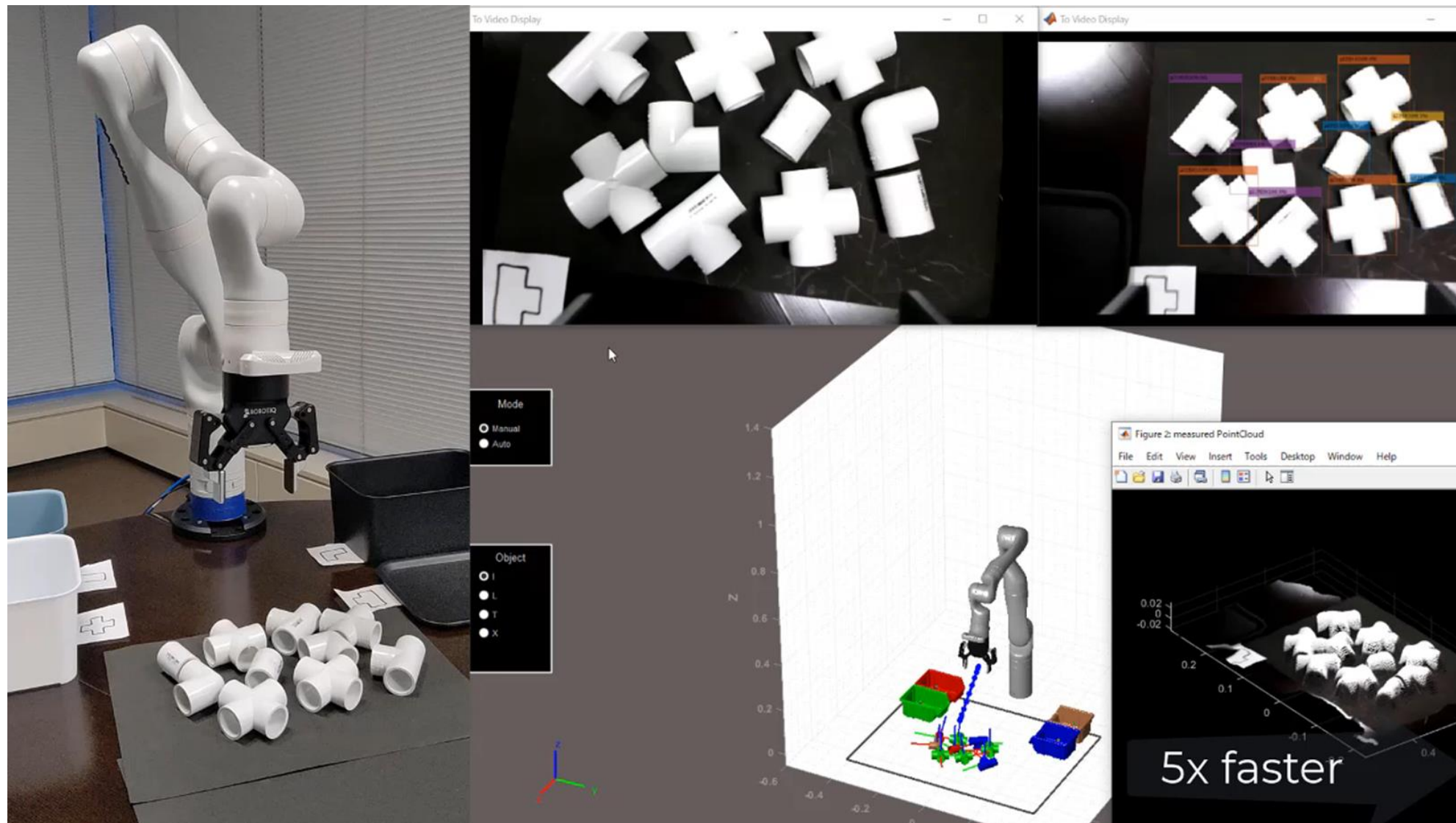
New    Open    Save    Print    Library Browser    Log Signals    Add Viewer    Signal Table    Stop Time: 15    Normal    Fast Restart    Step Back    Run    Step Forward    Stop    Data Inspector    Logic Analyzer    Bird's-Eye Scope

FILE    LIBRARY    PREPARE    SIMULATE    REVIEW RESULTS





# Triedenie súčiastok pomocou robota



# Triedenie súčiastok pomocou robota

Pre-processing



AI Model

Post-processing

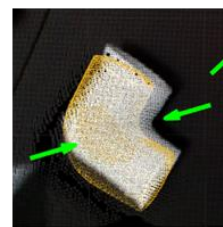
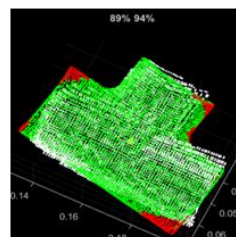
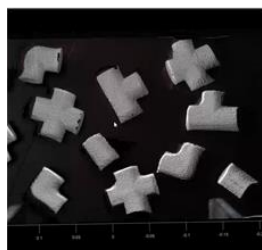
RGB-D Image

Point Cloud Reconstruction

Object Detection with YOLOv3

Matching with CAD models

6 DoF Object Pose



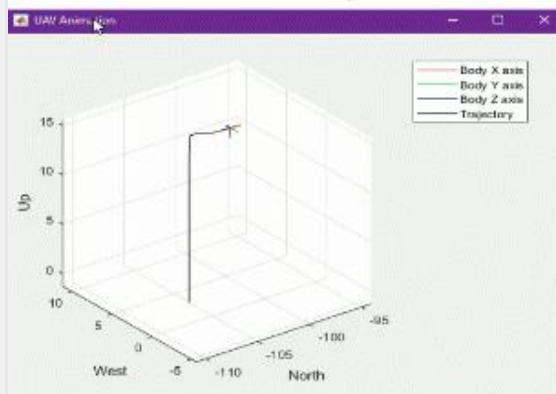
# Inšpekcia infraštruktúry pomocou UAV



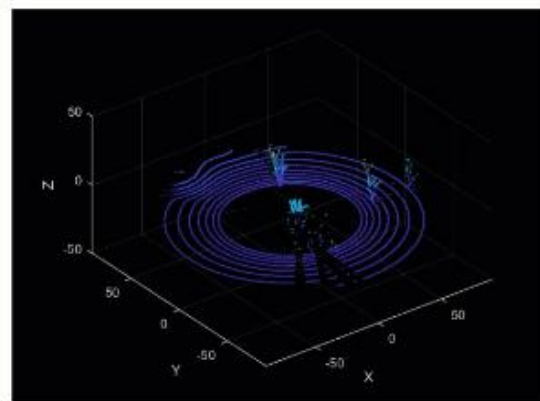
Photo Realistic Simulation



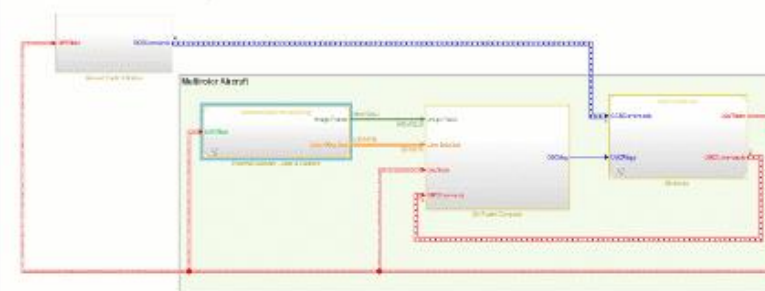
Bottom Facing Camera



Low Fidelity Animation



Virtual Lidar Sensor



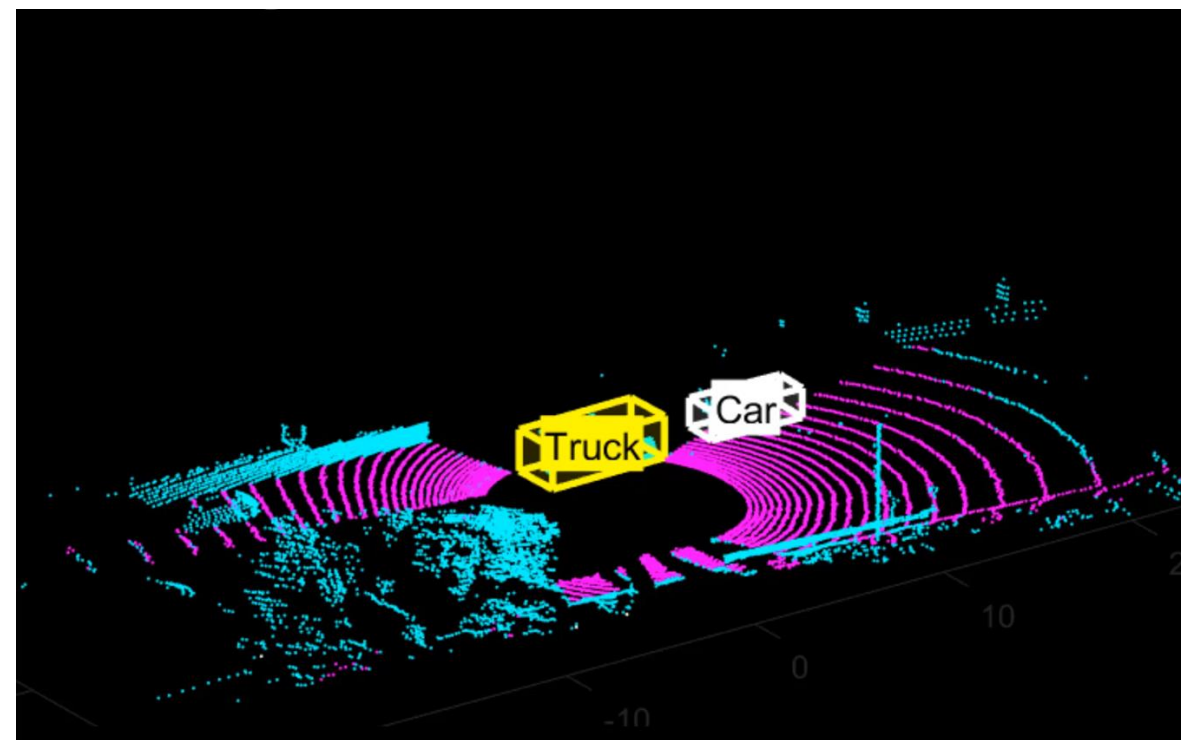
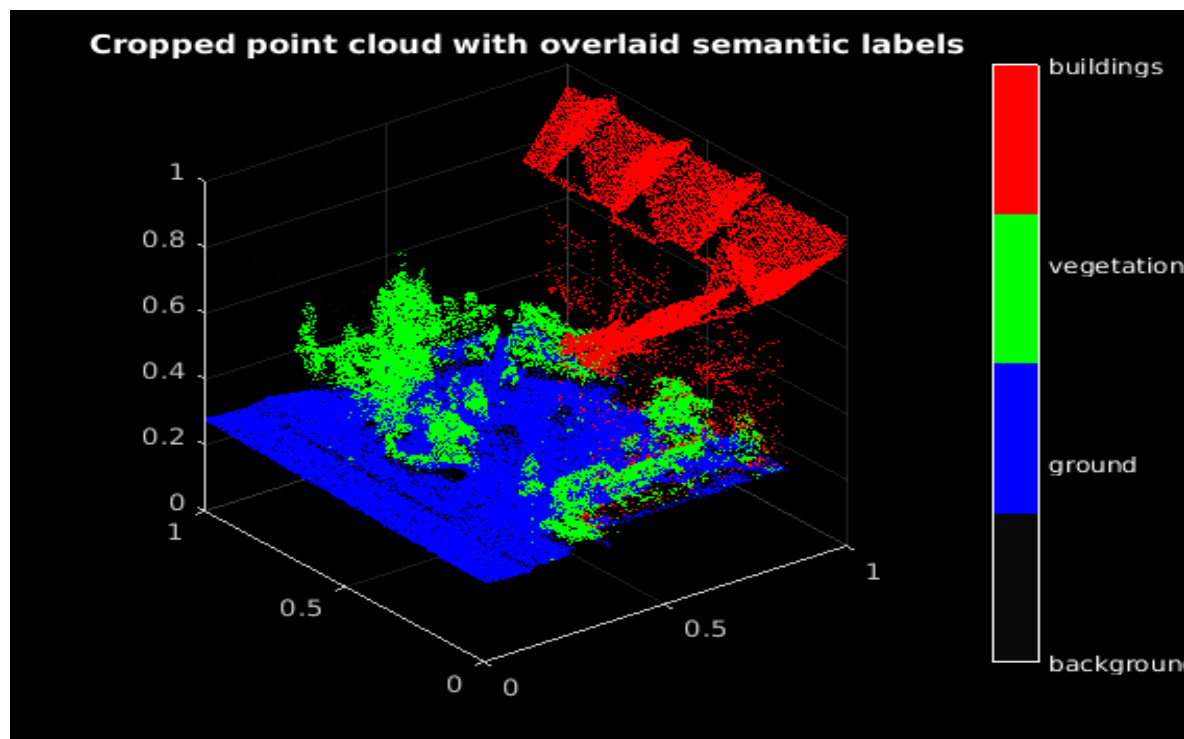
Deep Learning for UAV Infrastructure Inspection



# Využitie AI pri spracovaní dát z lidaru

Sémantická segmentácia

Detekcia objektov





# Segmentácia dát z lidar pomocou AI

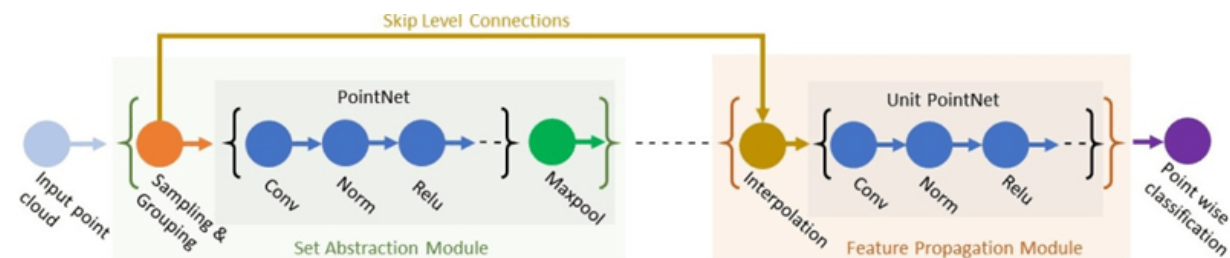
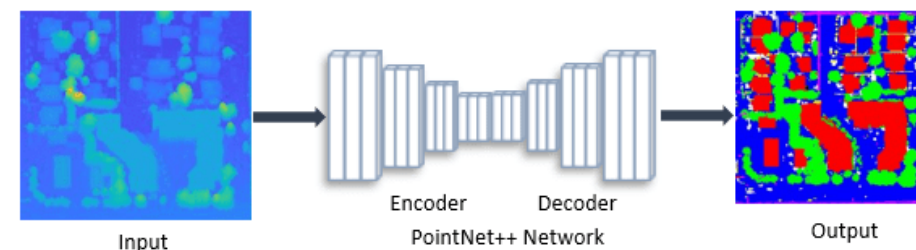
- Prístupy

- Voxely – transformáciou na voxely, môžeme použiť 3D CNN
- Multiview – projekcia na 2D obrázky, využíva 2D CNN, potreba obnoviť 3D štruktúru
- Point-based – sieť deep learningu sa priamo aplikuje na jednotlivé body



- Podporované siete

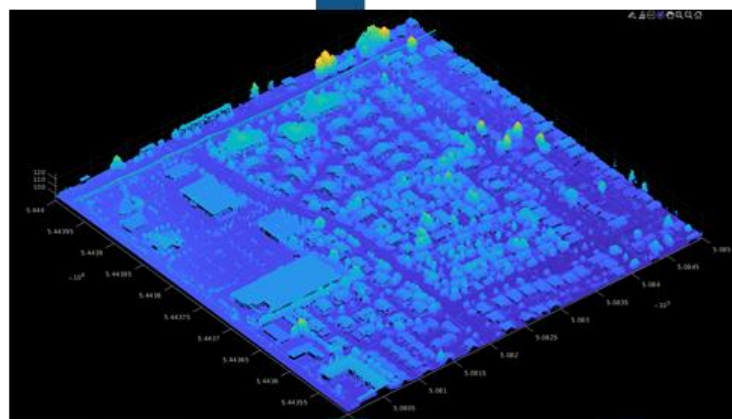
- PointNet, PointNet++, SqueezeSeg v2, PointSeg, SalsaNext



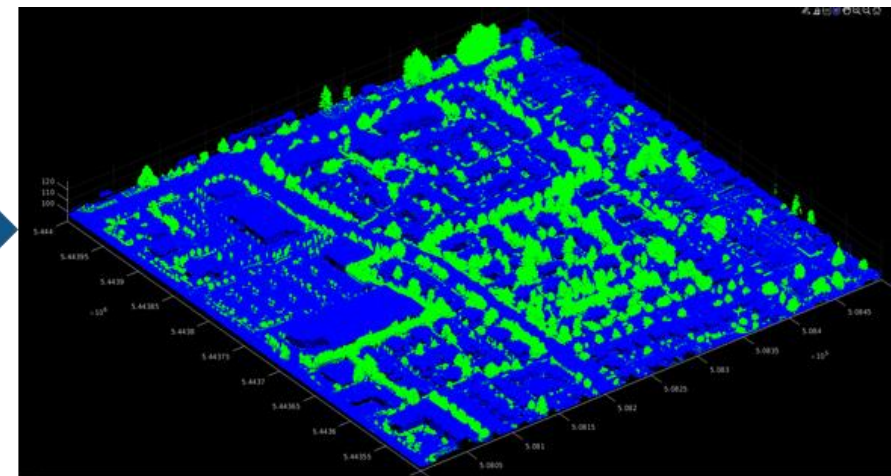
# Predtrénované siete

PointNet++

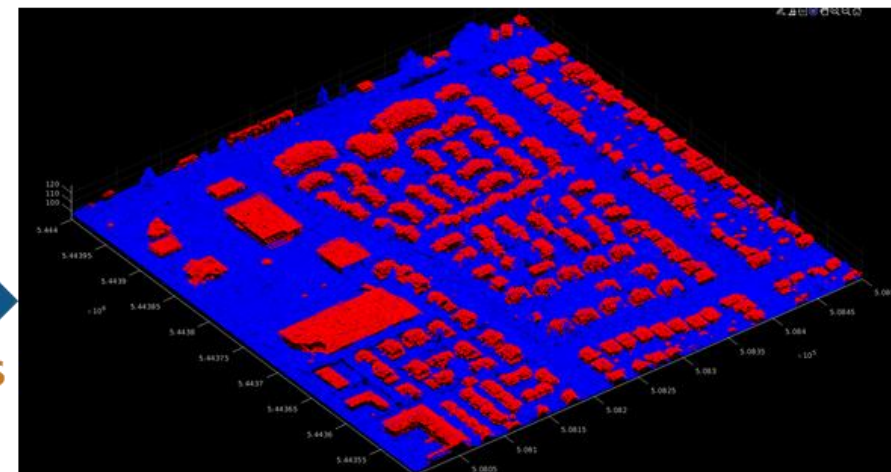
segmentAerialLidarVegetations



Input point cloud

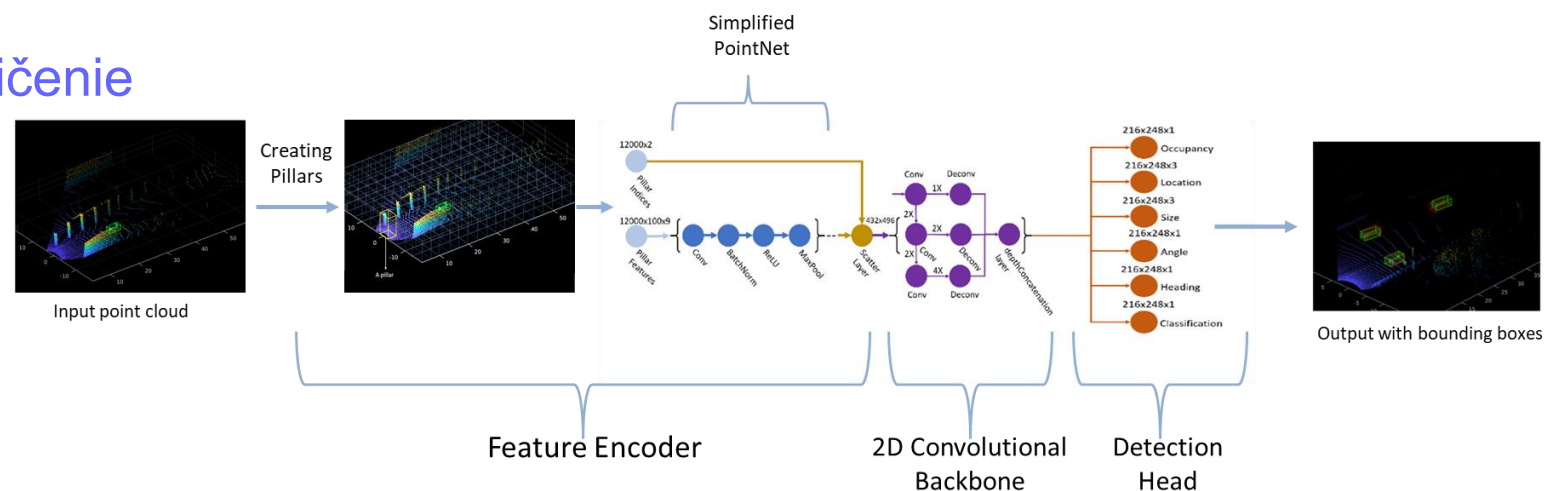
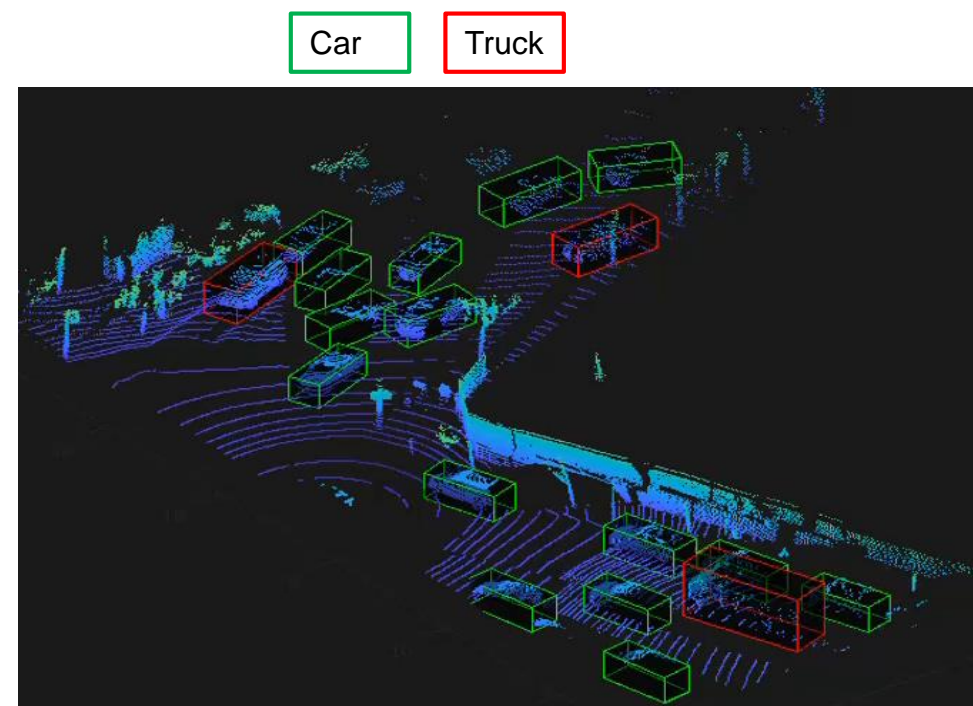


segmentAerialLidarBuildings



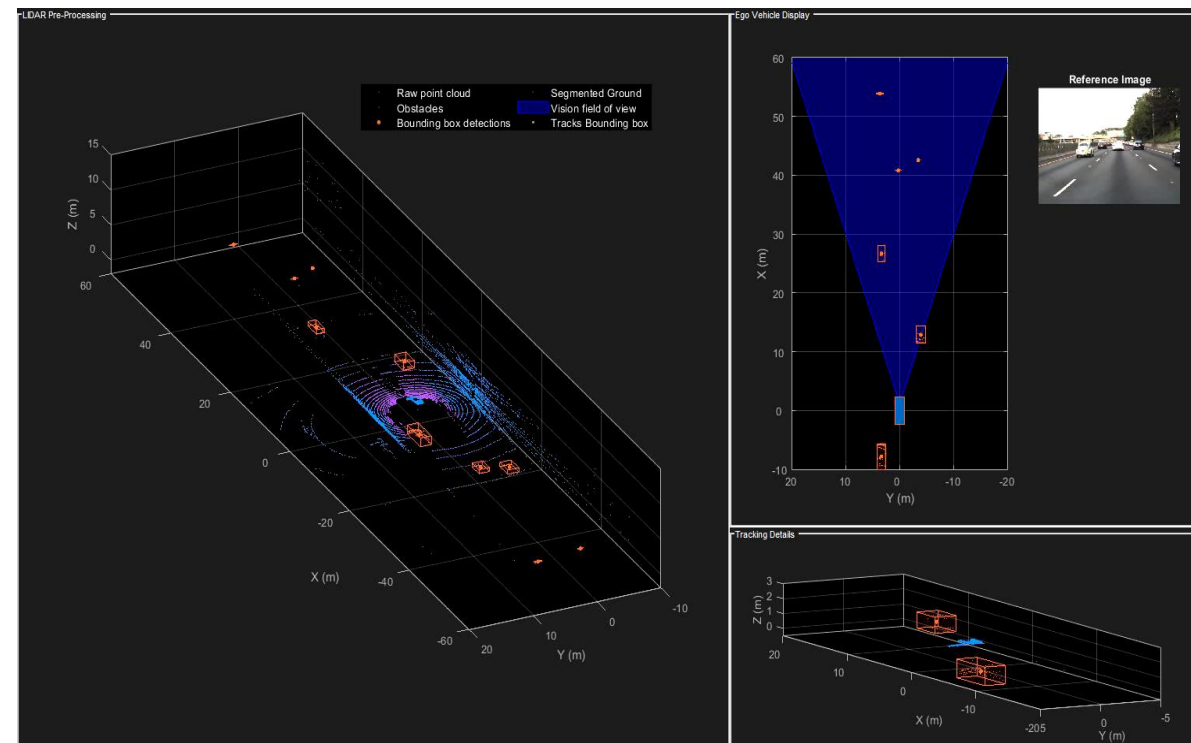
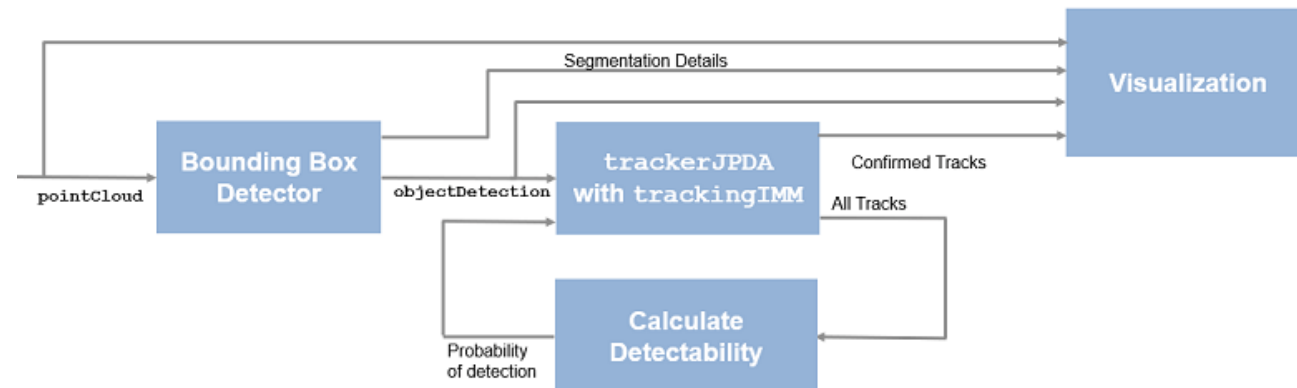
# Detekcia objektov - PointPillars

- pointPillarsObjectDetector
- Feature Encoder
  - konverzia na pseudoobrázok, rozdelenie do mriežky – piliere, využíva PointNet
- 2D convolutional backbone
  - spracováva pseudo-obrázok
- Detection head
  - deteguje a vytvára 3D ohraničenie



# Sledovanie objektov

- Vnímanie situácie
  - čo sa deje okolo nás
  - sledovanie polohy, rýchlosti, veľkosti, orientácie
- Kombinácia viacerých snímačov
  - lidar, radar, kamera
- Multi-object tracker
  - Joint probabilistic data association (JPDA)
  - Interacting Multiple Model (IMM) tracking filter – konštantná rýchlosť a točenie, aj pri zmene jazdného pruhu
- Sensor Fusion and Tracking Toolbox

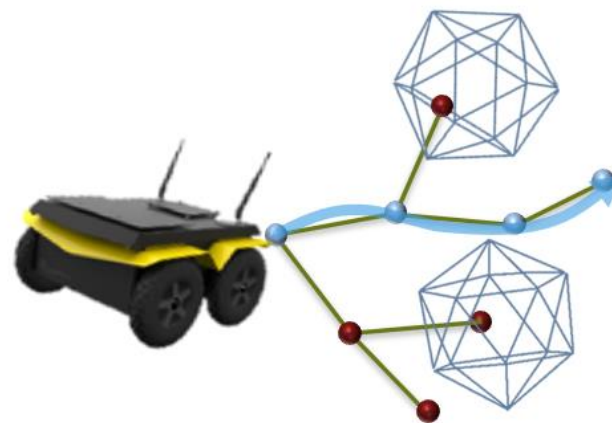




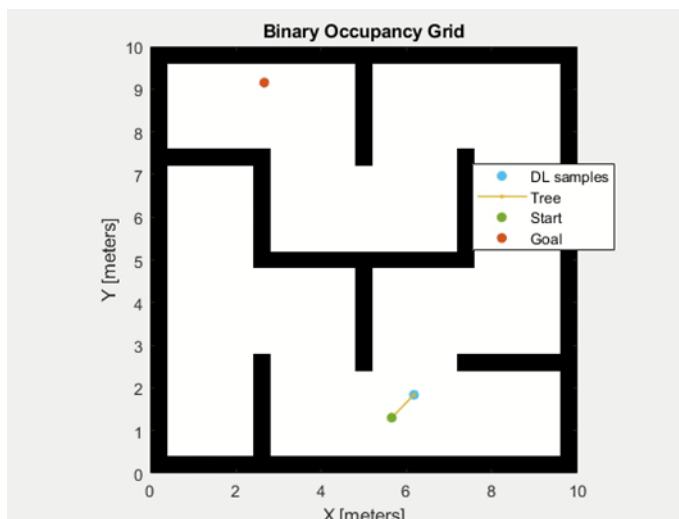
# Hlavné súčasti autonómnych systémov



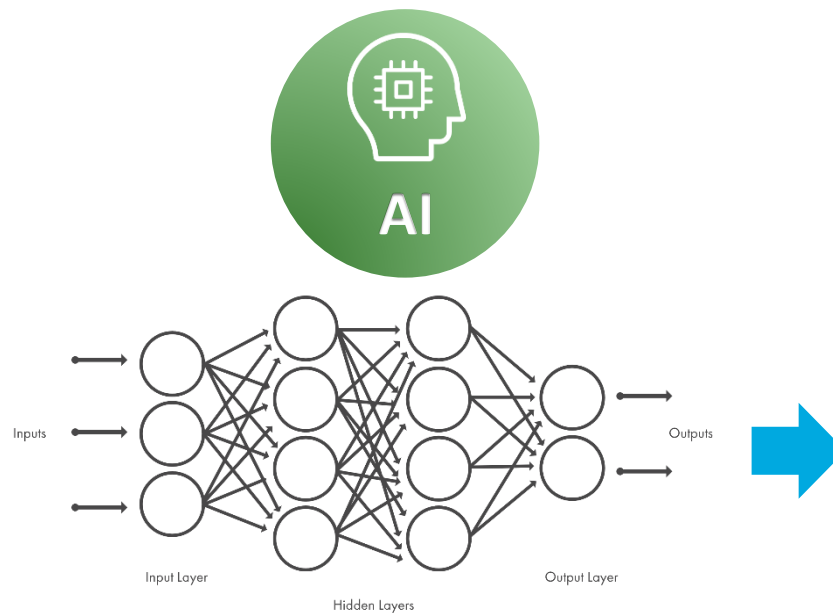
Plánovanie



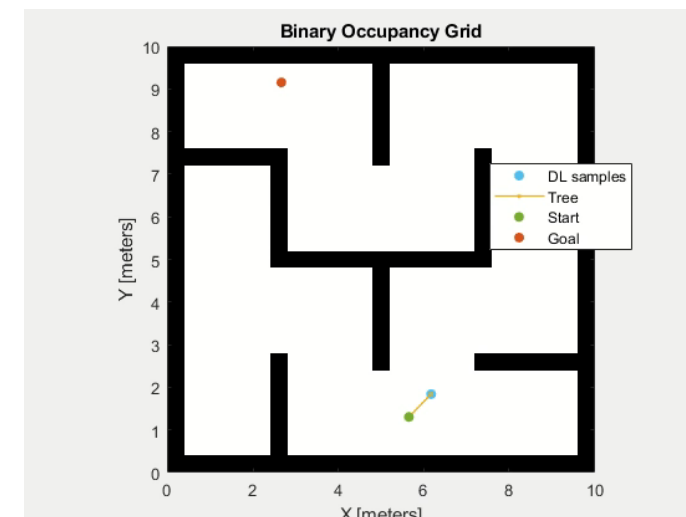
# Plánovanie trasy pomocou AI



Definícia počiatočnej a konečnej polohy



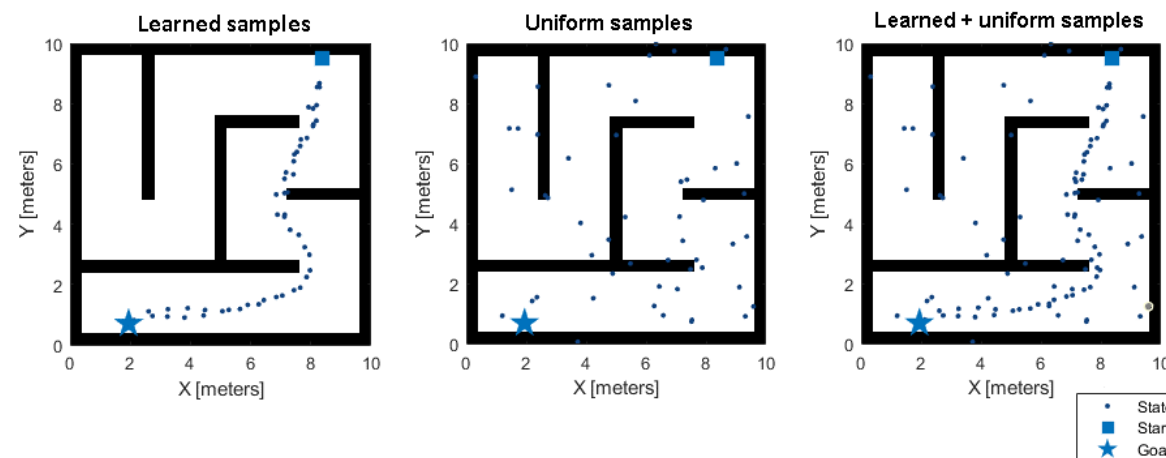
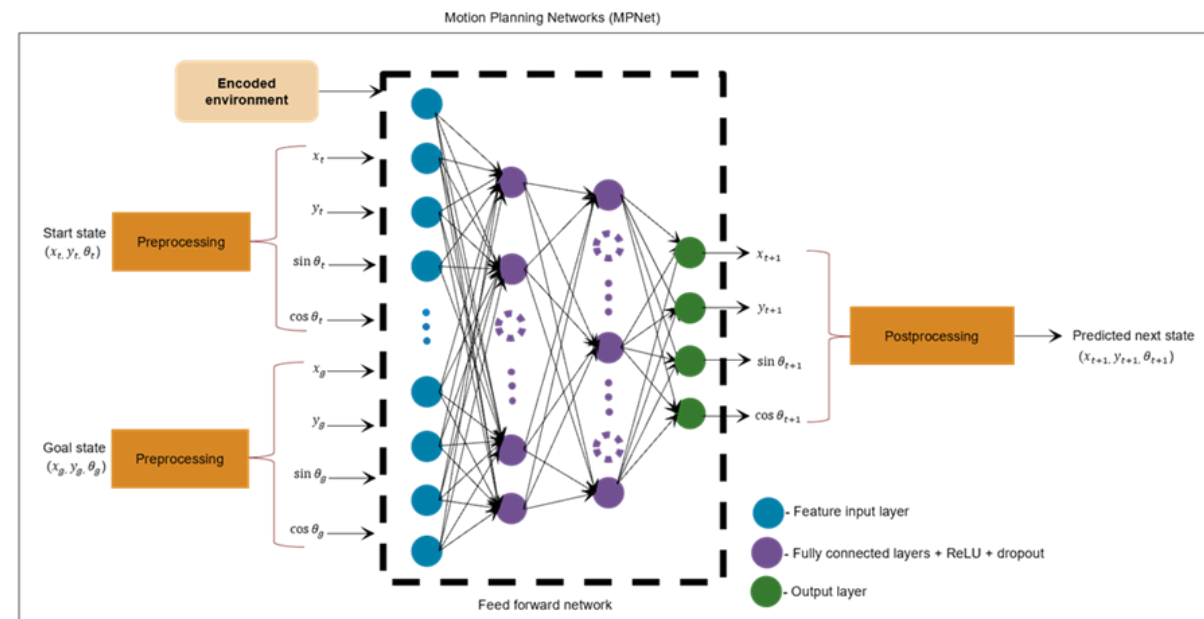
Plánovanie trasy pomocou AI vzorkovania



Trasa naplánovaná v prijateľnom čase

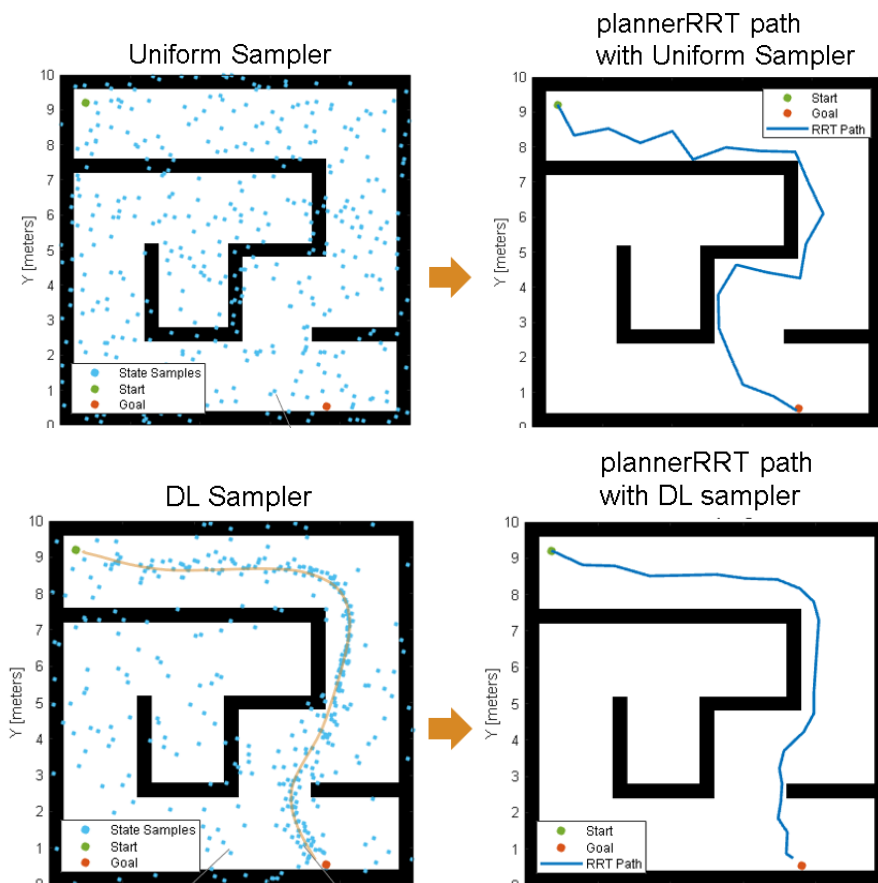
# Siete plánovania pohybu

- Motion Planning Networks (MPNet)
  - hľadanie optimálnej trasy – Deep Learning
  - generovanie vzorky medzi 2 stavmi
  - vzorky sa využívajú na plánovanie (RRT\*)
- Architektúra
  - modul kódovania mapy (väčšinou riedka)
  - modul plánovania – mapa, štart, cieľ
    - učí sa s pozorovateľom (klasické plánovače)
- Funkcie na
  - tréning od začiatku
  - tvorbu vzoriek
  - plánovanie trasy

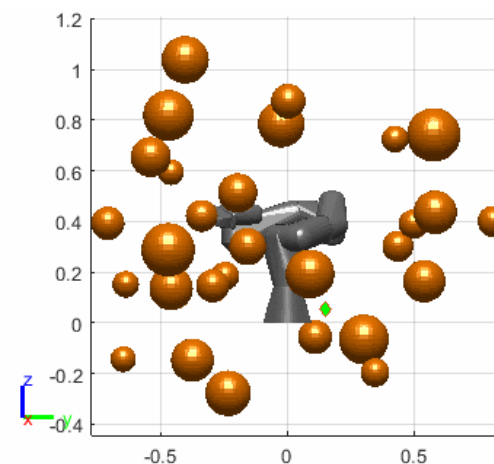


# Plánovanie trasy pomocou AI

AI + Plánovanie vzorkami  
(Motion Planning Networks)

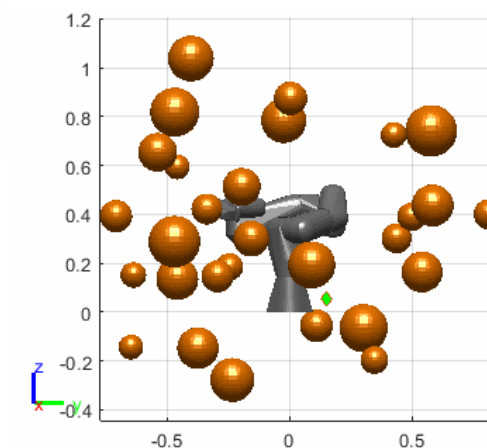


AI + Plánovanie optimalizáciou  
(Deep-Learning-Based CHOPM)



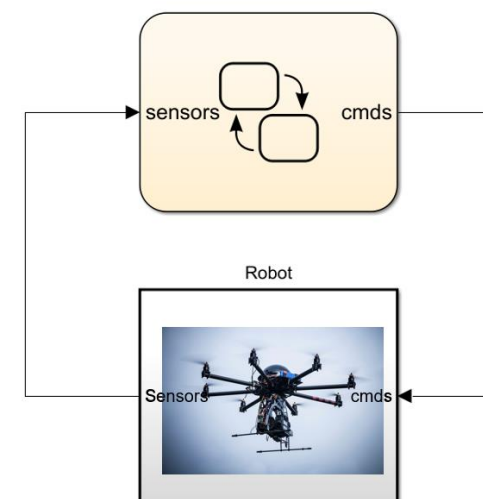
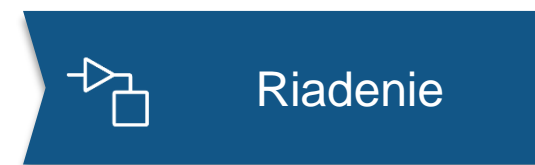
Dĺžka trasy bez  
AI: 1.8 m

Dĺžka trasy s AI:  
0.8 m



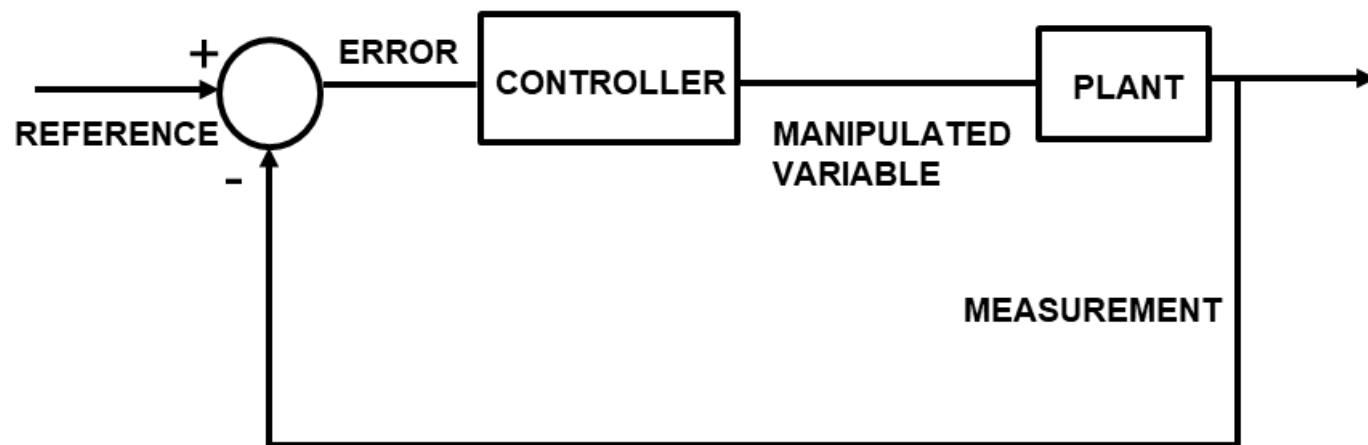


# Hlavné súčasti autonómnych systémov

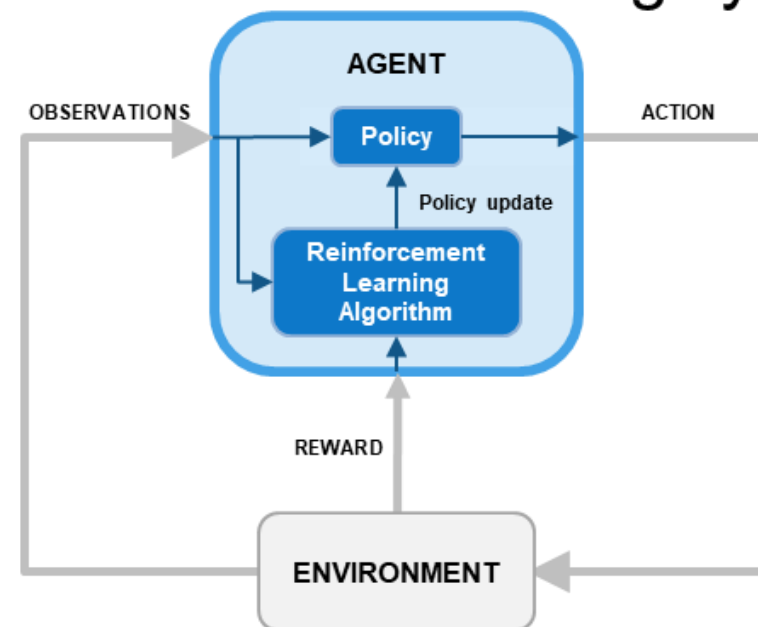


# Reprezentácia fixed-point dát v prostredí MATLAB

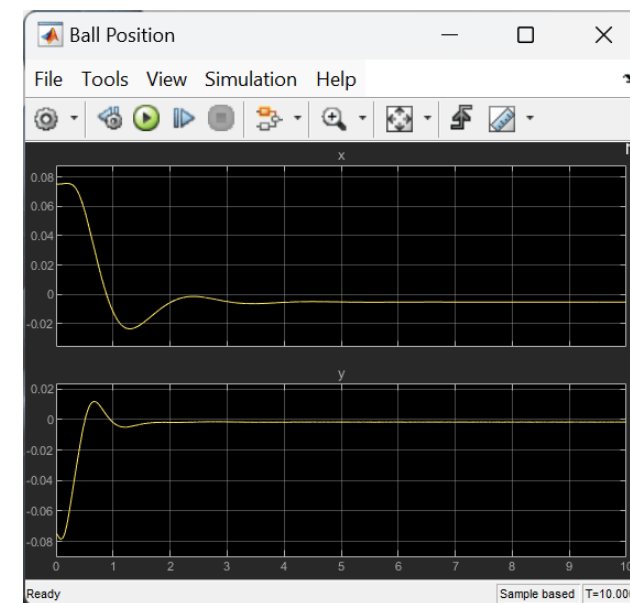
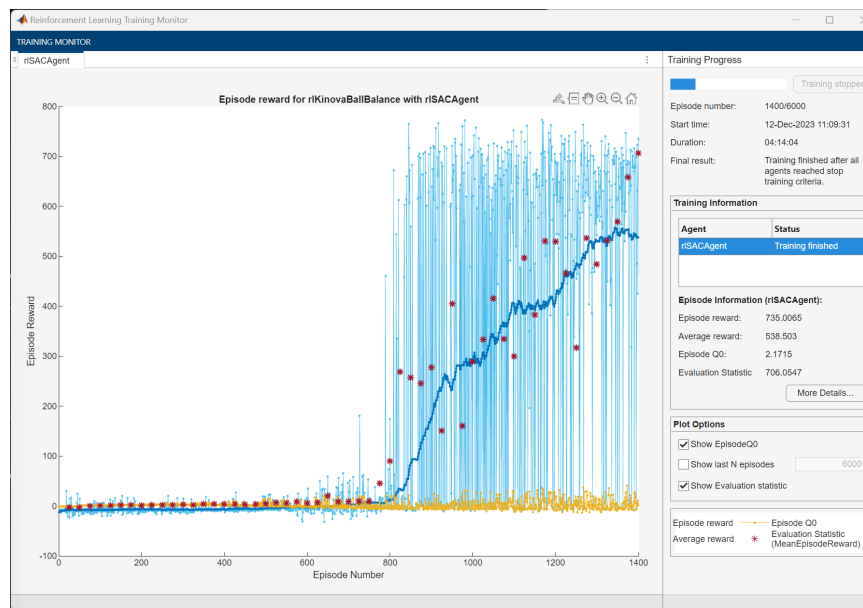
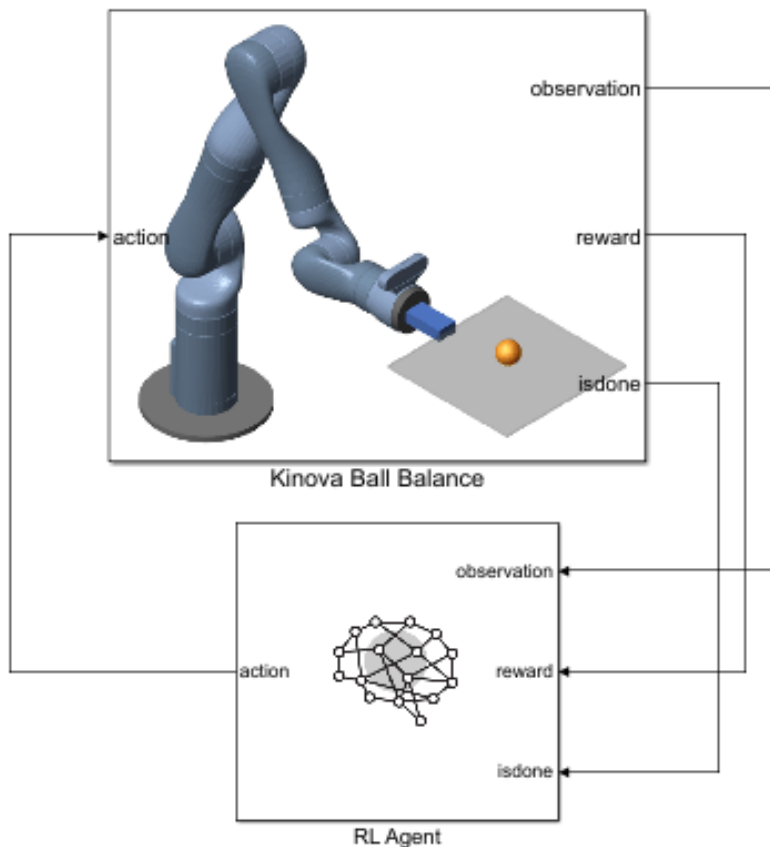
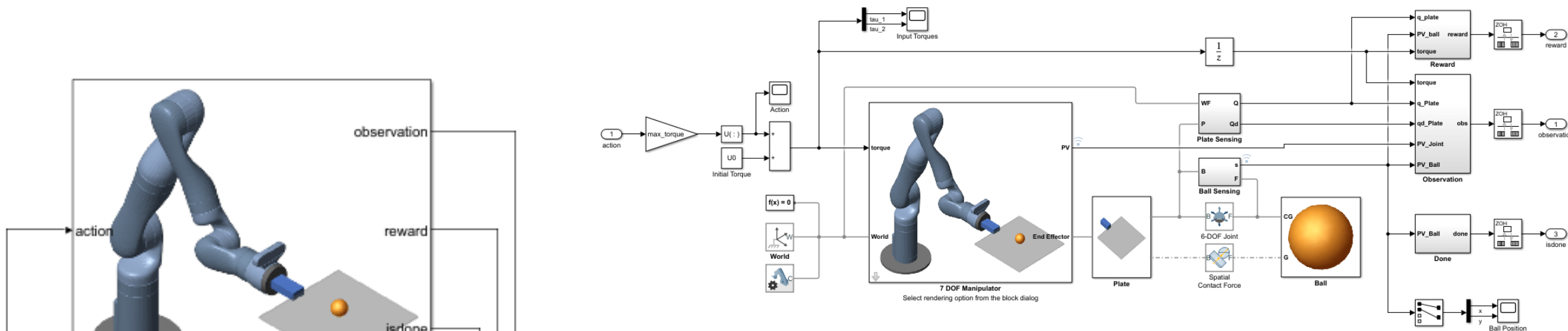
Control system



Reinforcement learning system

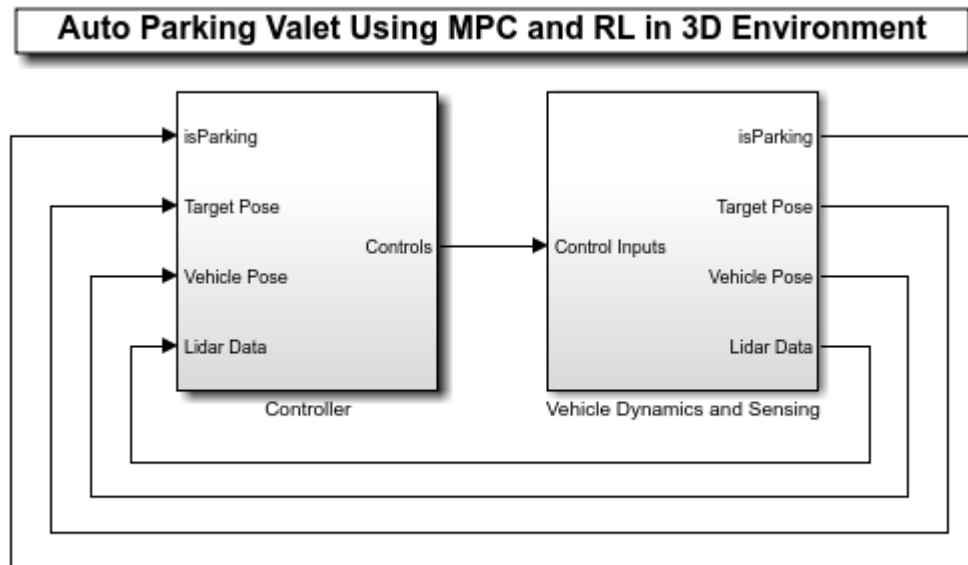


# Balansovanie loptičky pomocou agenta RL

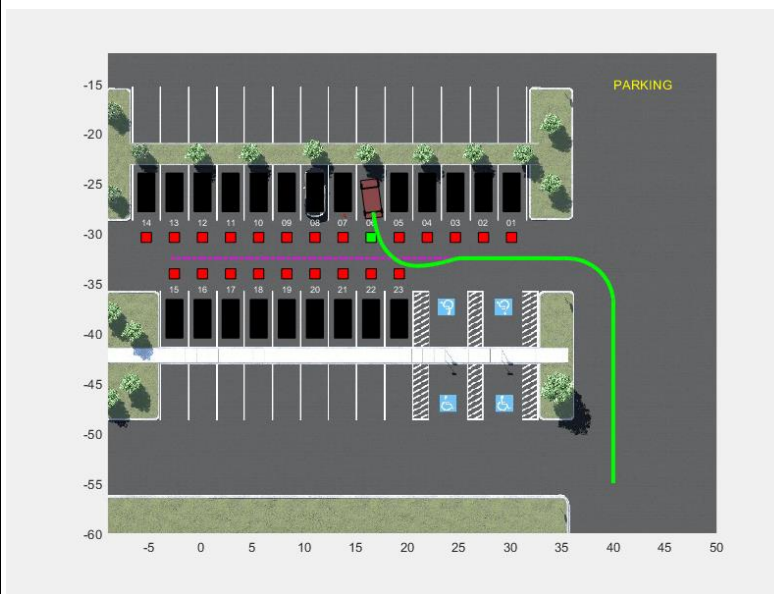
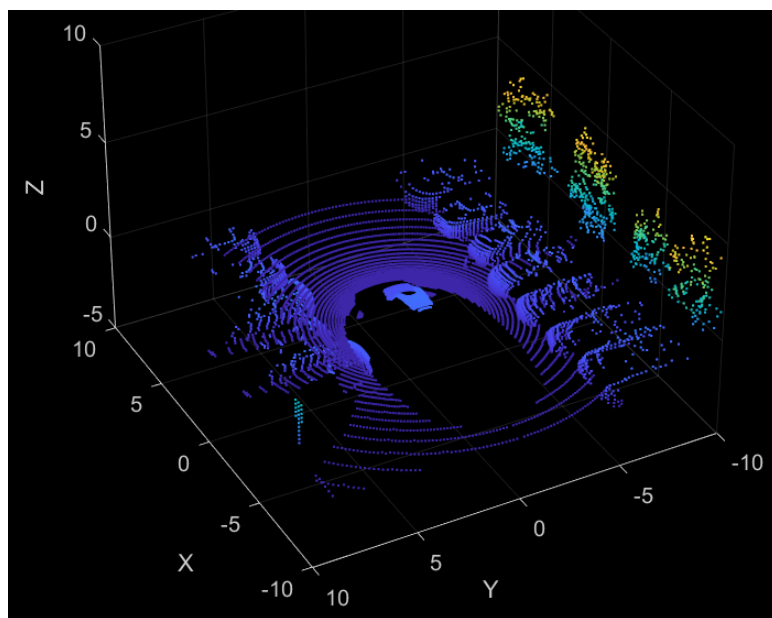


vzdialenosť loptičky a stredu  
poloha a orientácia plochy  
energia/sila regulátora

# Automatická parkovacia služba



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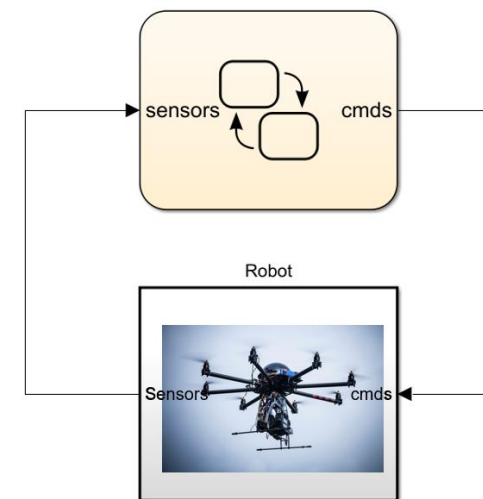
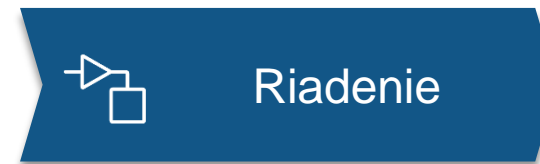
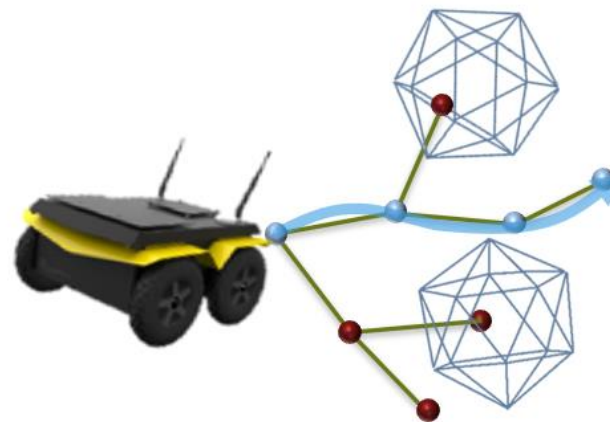
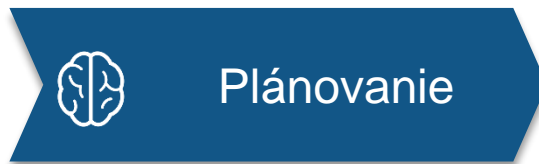
**Adaptívny MPC**  
konštantná rýchlosť po trase

**Reinforcement Learning**  
vykonanie parkovacieho manévru

poloha, natocenie vozidla/kolies  
ukončenie parkovania, kolízie



# Hlavné súčasti autonómnych systémov



Ďakujem za pozornosť