Object Hunt

Final Presentation

Manuel Audran
Tim Mennicken
Robert Rose

University of Applied Sciences Cologne

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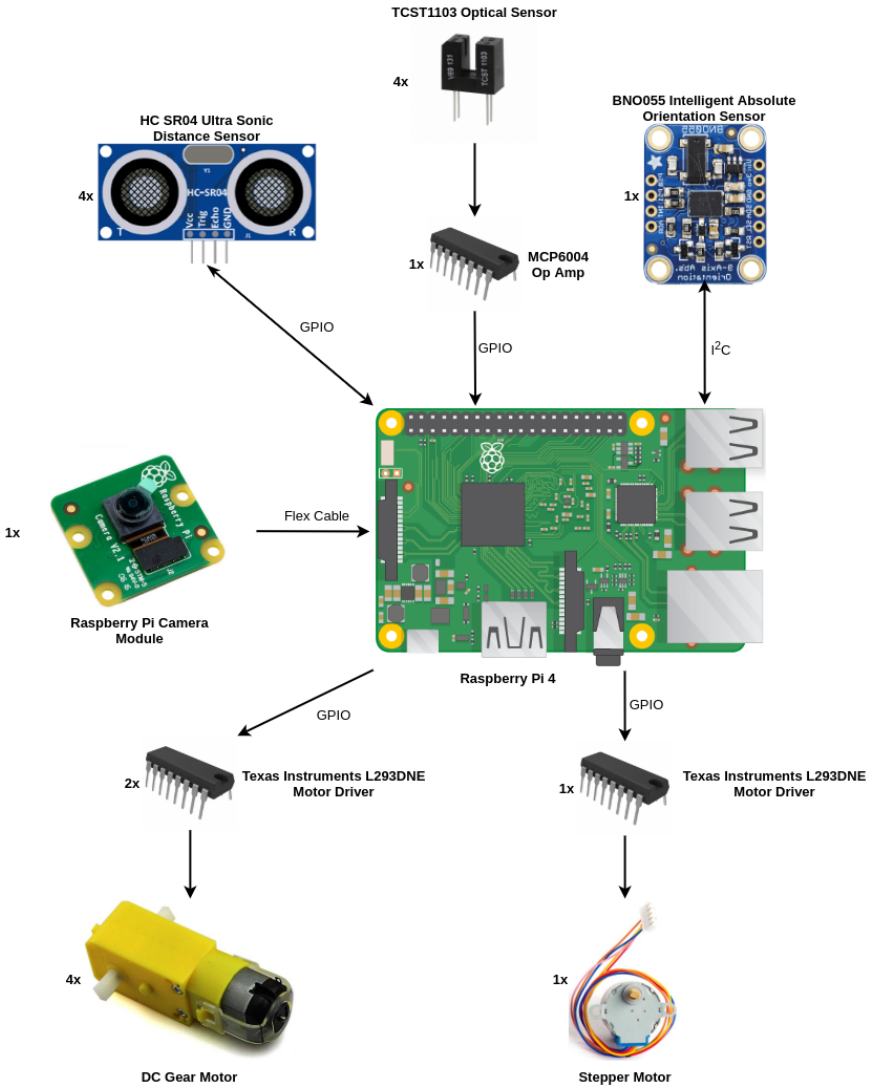
Hardware Overview

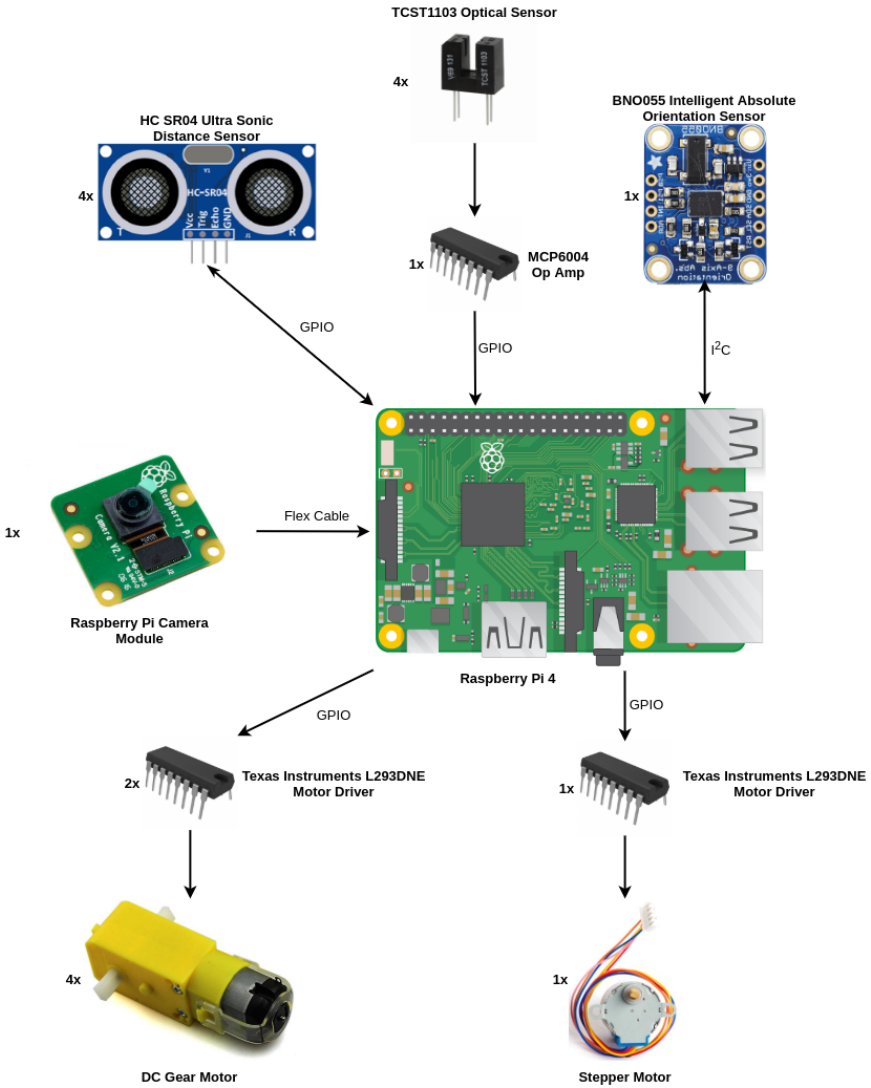
- Ultra sonic distance sensor
- Infrared revolution sensor
- Smart movement sensor
- Camera module



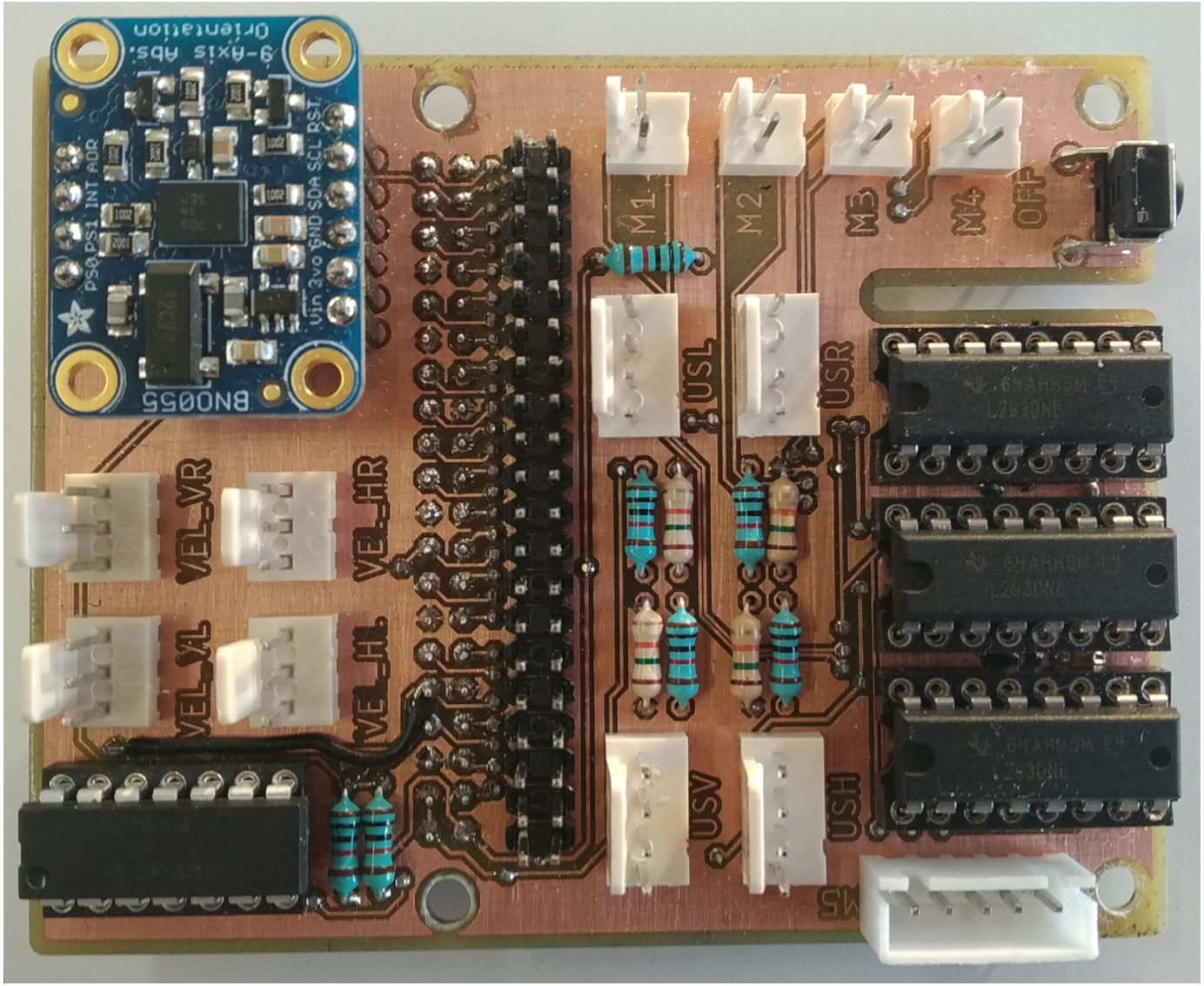
Hardware Overview

- Ultra sonic distance sensor
- Infrared revolution sensor
- Smart movement sensor
- Camera module

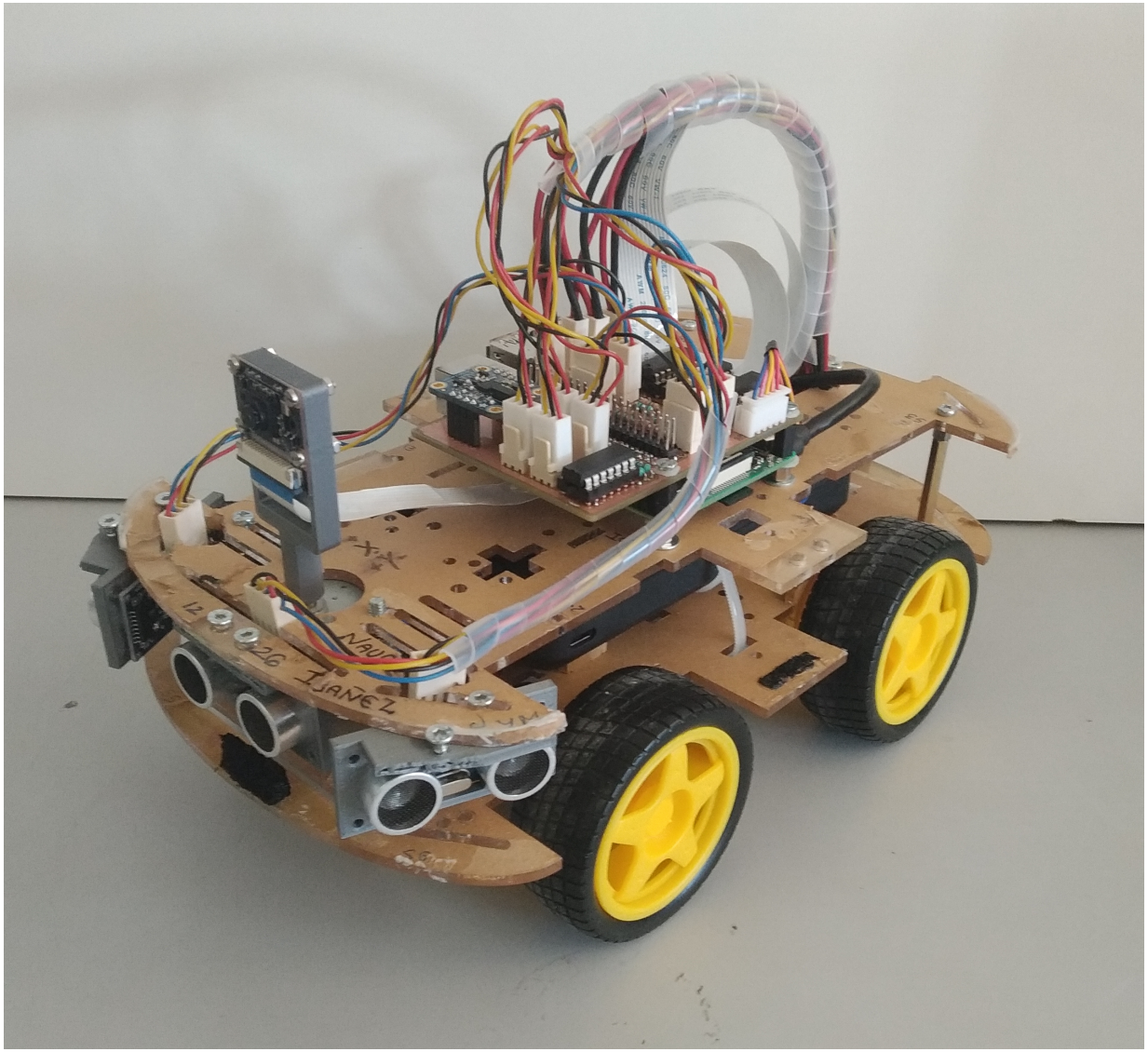
- DC gear motor
- Stepper motor



PCB Board



Assembly



Software Principles

- Communication
  - Via TCP/ IP
  - Independent from other devices
  - Beyond system border

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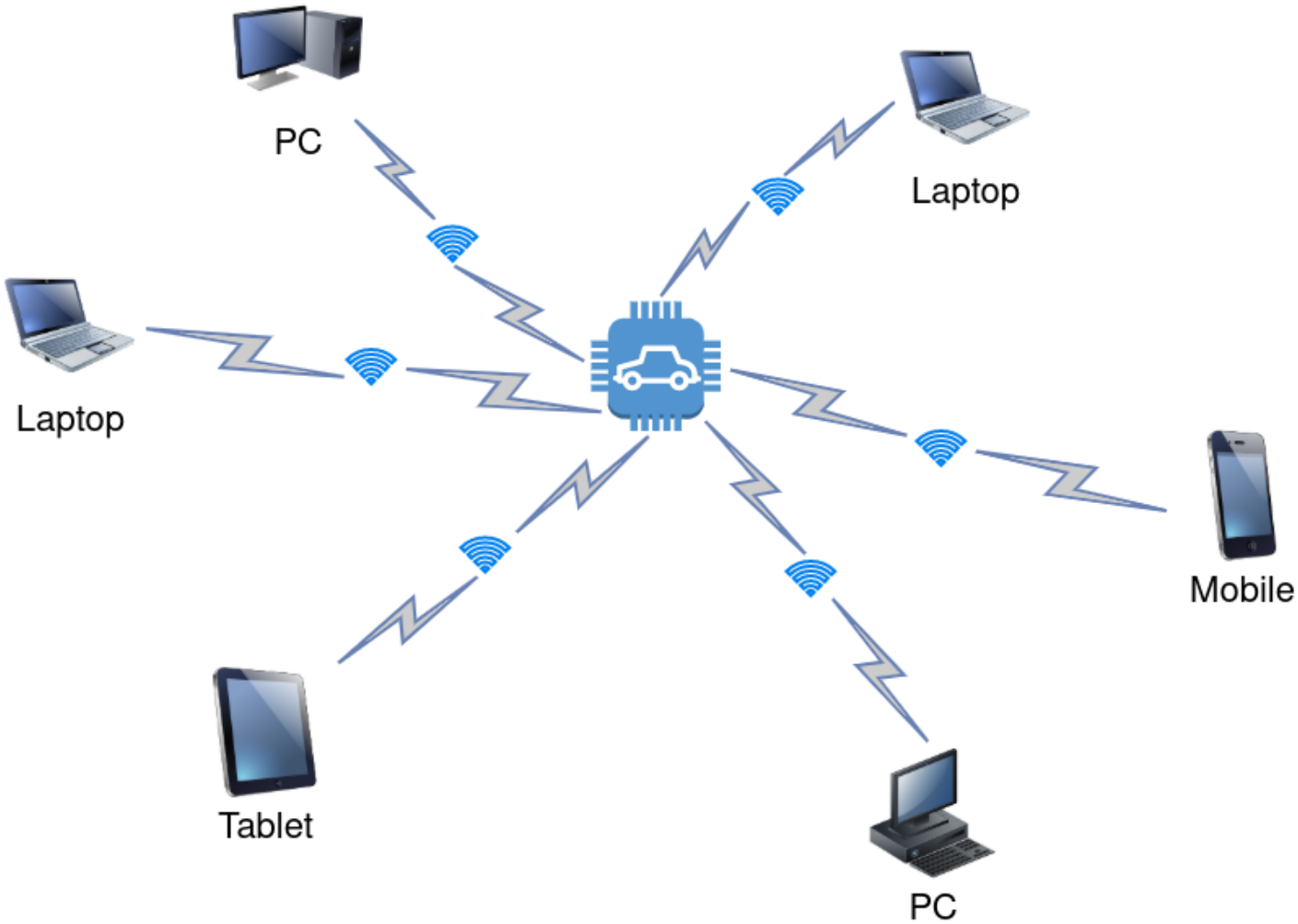
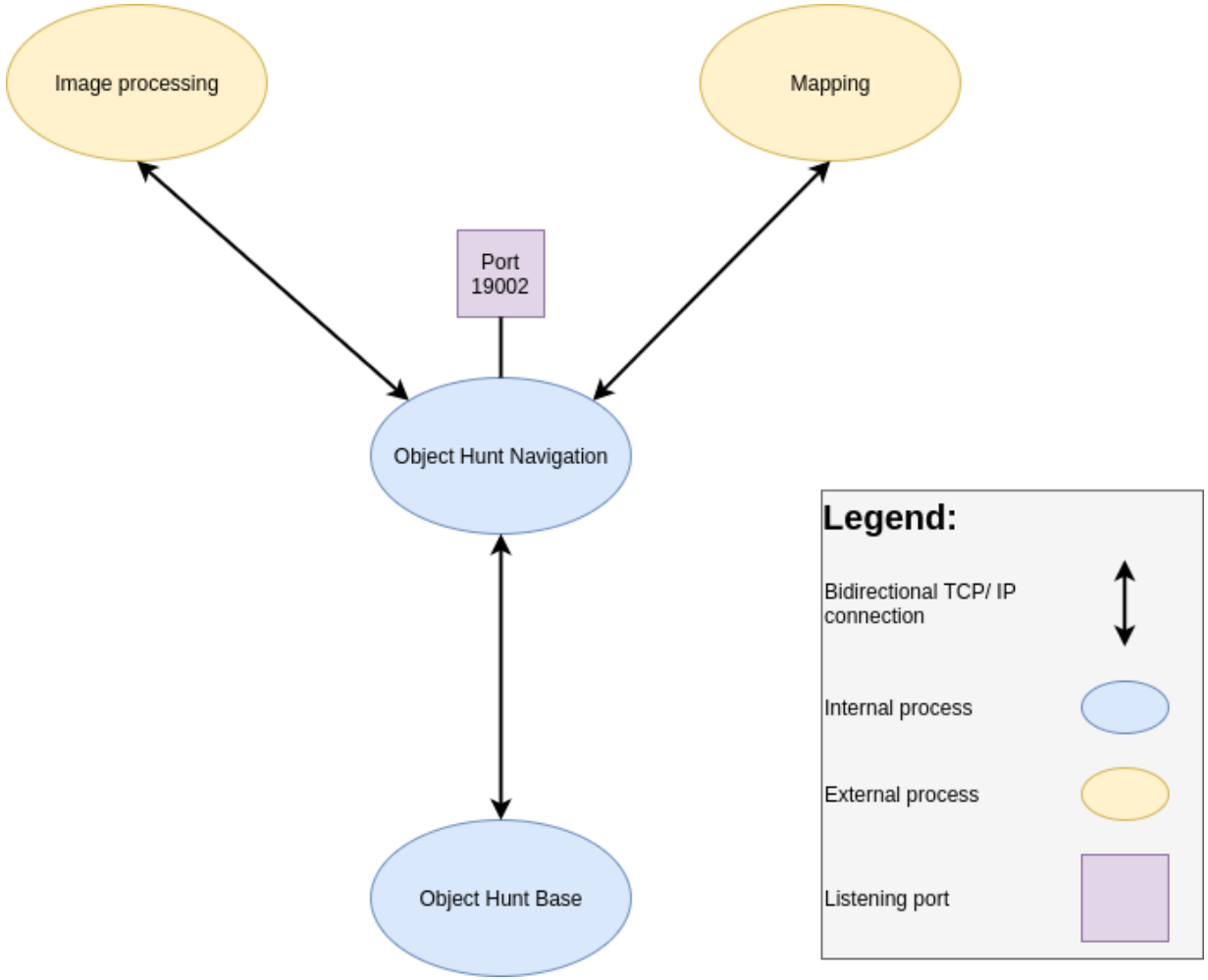
  - Independent from other devices
  - Beyond system border
- Economical
  - No unnecessary CPU consume
  - Fast reaction times
  - Event driven
- Documentation
  - Complete
  - Easy accessible

Connection Overview



Connection Implementation



Base Process

- Exclusively accesses the hardware
- Receives commands and requests from the navigation process
- Continuous communication with the navigation process

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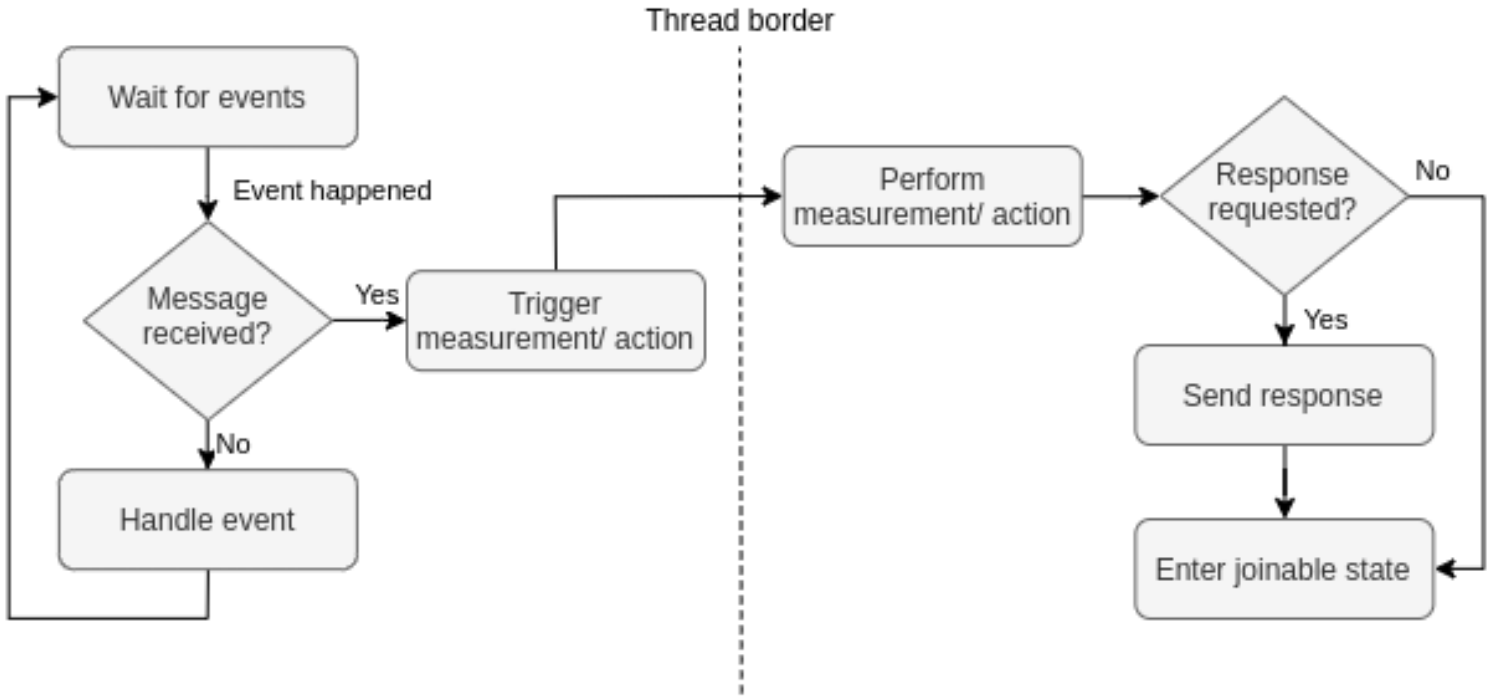

Navigation Process

- Requests periodically sensor readings
- Sends navigation commands
- Handles connections with further processes

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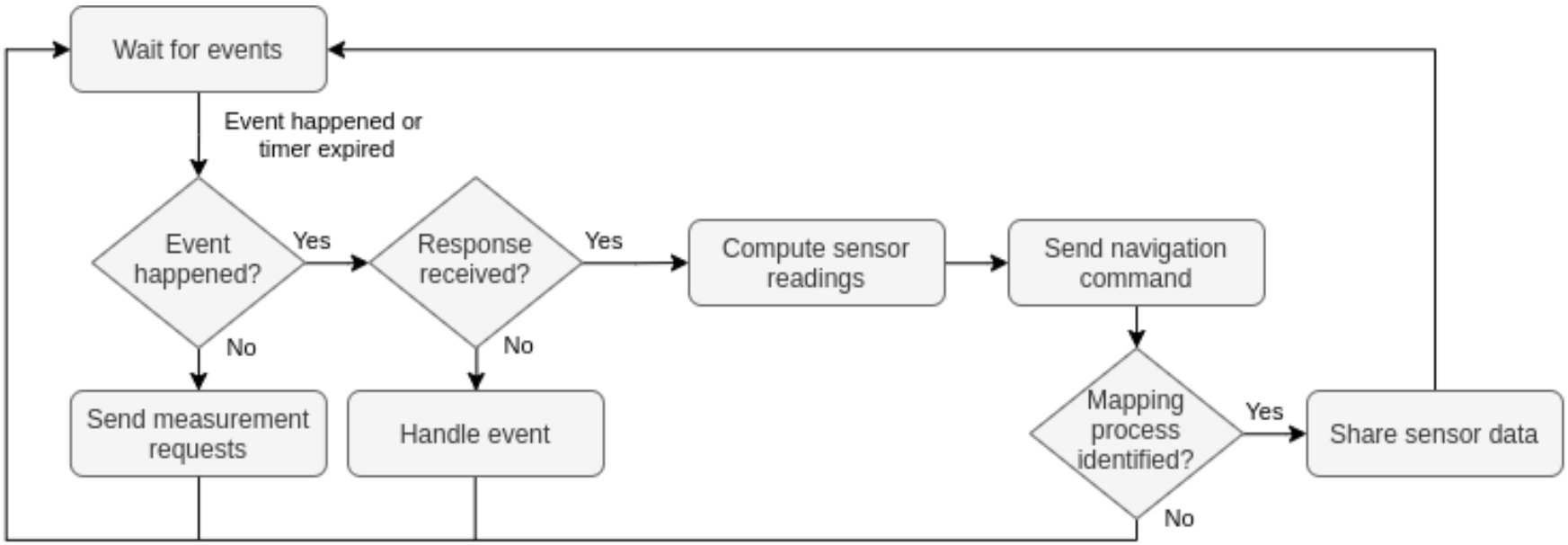


Software Setup

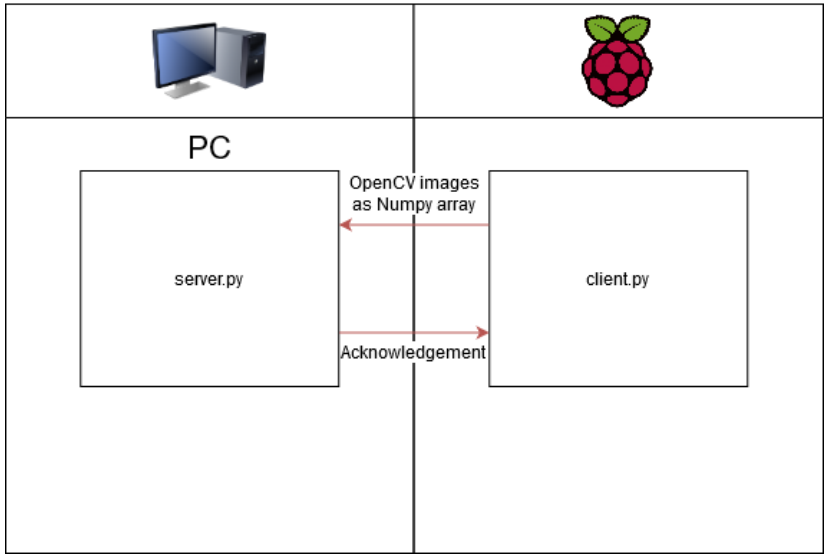
- Python 3.7.3
- OpenCV 4.1.2
- ImageZMQ (Python wrapper for ZMQ functionalities)
- MobileNet v2 SSD
- COCO dataset

Framework - Open Source Computer Vision Library

- Platform independent library written in C++
- Available as Python pip package
- DNN module to utilize pretrained Tensorflow models
- Offers utilization methods to present the images

Streaming

- First analysis shows Raspberry Pi is not capable of real-time object detection
- Solution ⇒ stream the video and process it on the PC
- ImageZMQ is based on ZeroMQ, made for transporting OpenCV images over network
- Results in two processes, connected via sockets



Model

Requirements:

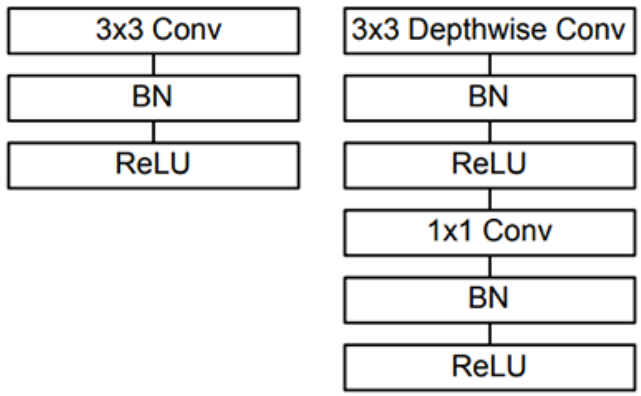
- Object detection (tennis ball as defined object)
- Real-time processing
- Sufficient accuracy

$\Rightarrow$ MobileNet in combination with SSD offers an efficient solution for embedded systems with real-time object detection

$\Rightarrow$ COCO dataset includes 90 different classes

Model - Mobilnet Architecture

- Main difference: Depthwise separable convolution
- Splits up convolution in two parts
  - 3x3 depthwise Conv
  - 1x1 pointwise Conv
- Reduces the number of trainable parameters remarkably
- Trade-off is less accuracy



Model – Single Shot Detection

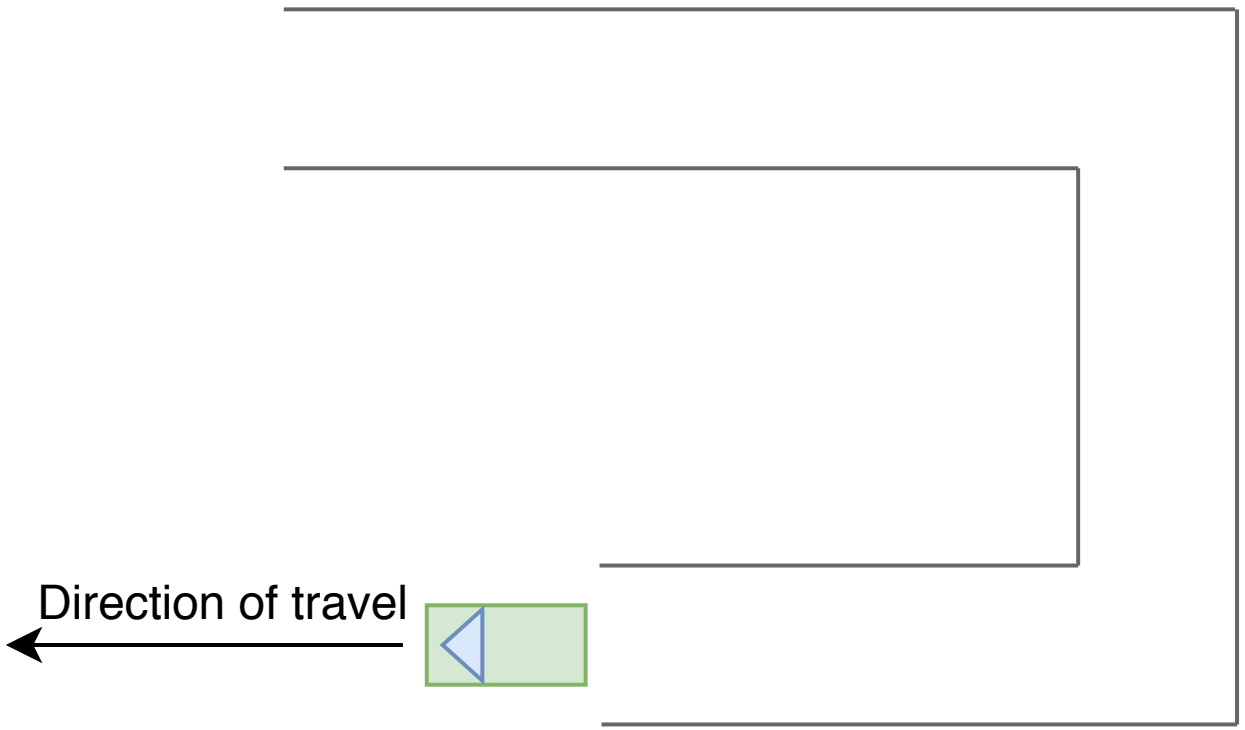
- Defines default boxes
- Generates scores for each category and default box
- Adjusts the box to match the object shape

- Three commonly used object detection methods:
  - Faster R-CNN
  - YOLO
  - SSD

Method	mAP	FPS	batch size	# Boxes	Input resolution
Faster R-CNN (VGG16)	73.2	7	1	~ 6000	~ 1000 × 600
Fast YOLO	52.7	155	1	98	448 × 448
YOLO (VGG16)	66.4	21	1	98	448 × 448
SSD300	74.3	46	1	8732	300 × 300
SSD512	76.8	19	1	24564	512 × 512
SSD300	74.3	59	8	8732	300 × 300
SSD512	76.8	22	8	24564	512 × 512

Mapping & Routing

Example: Tunnel



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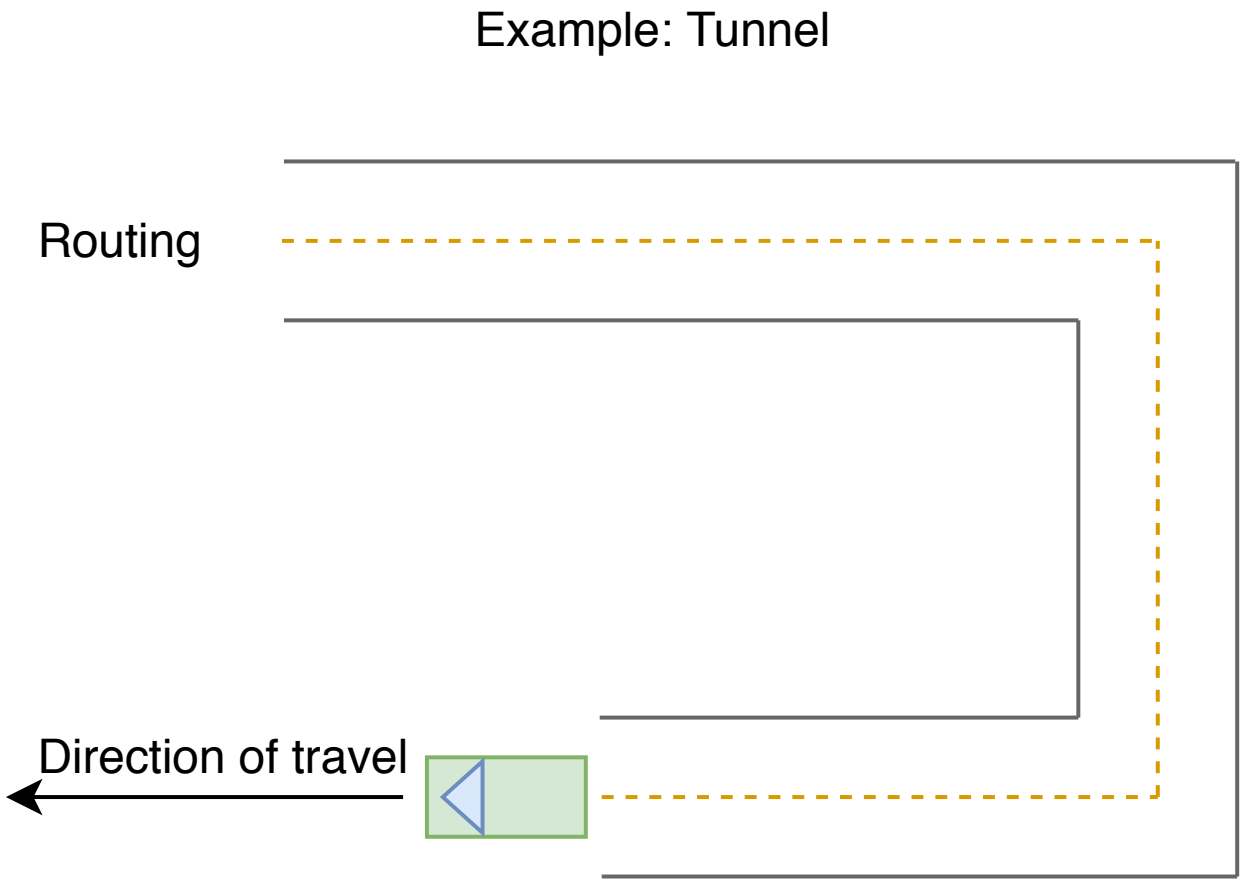

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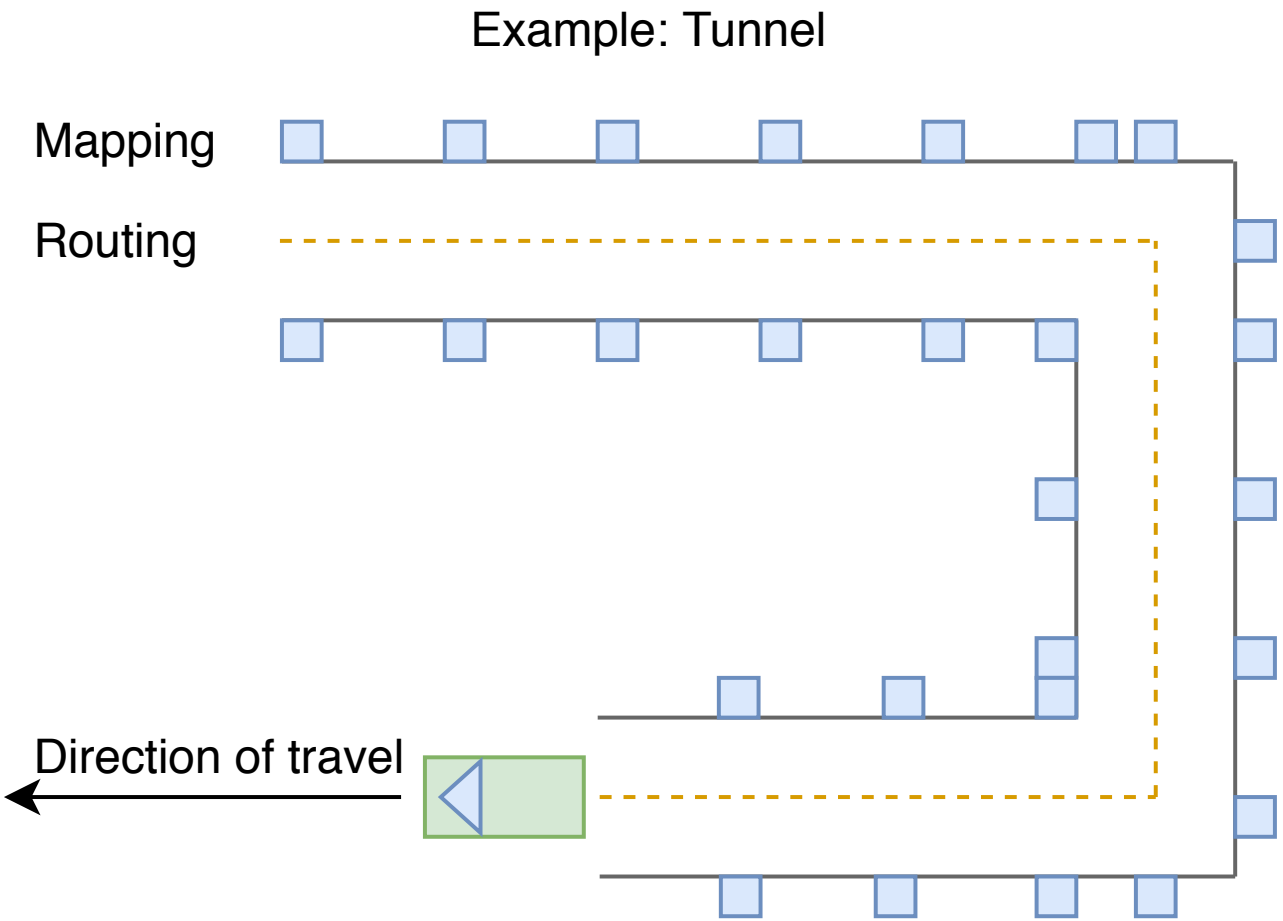
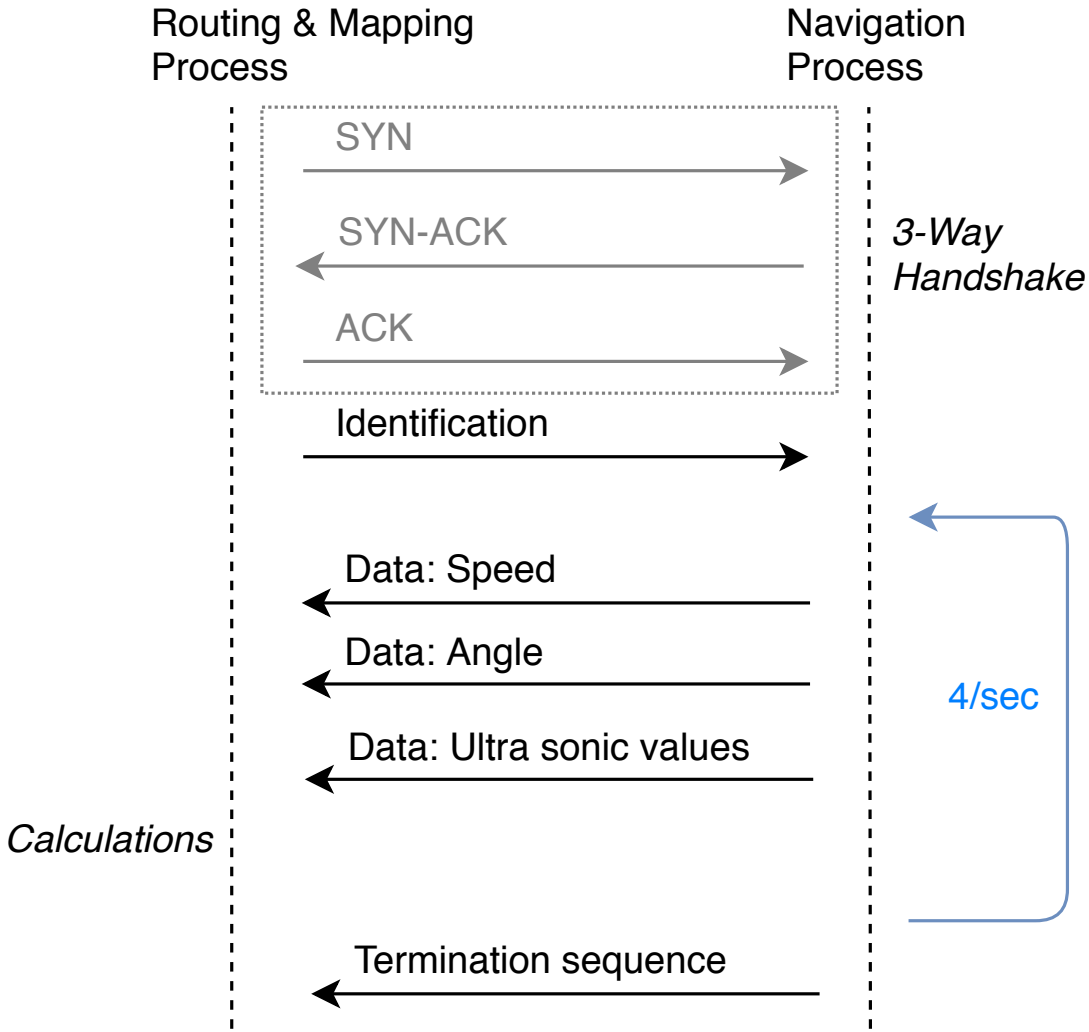
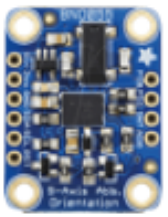


Communictaion



Routing

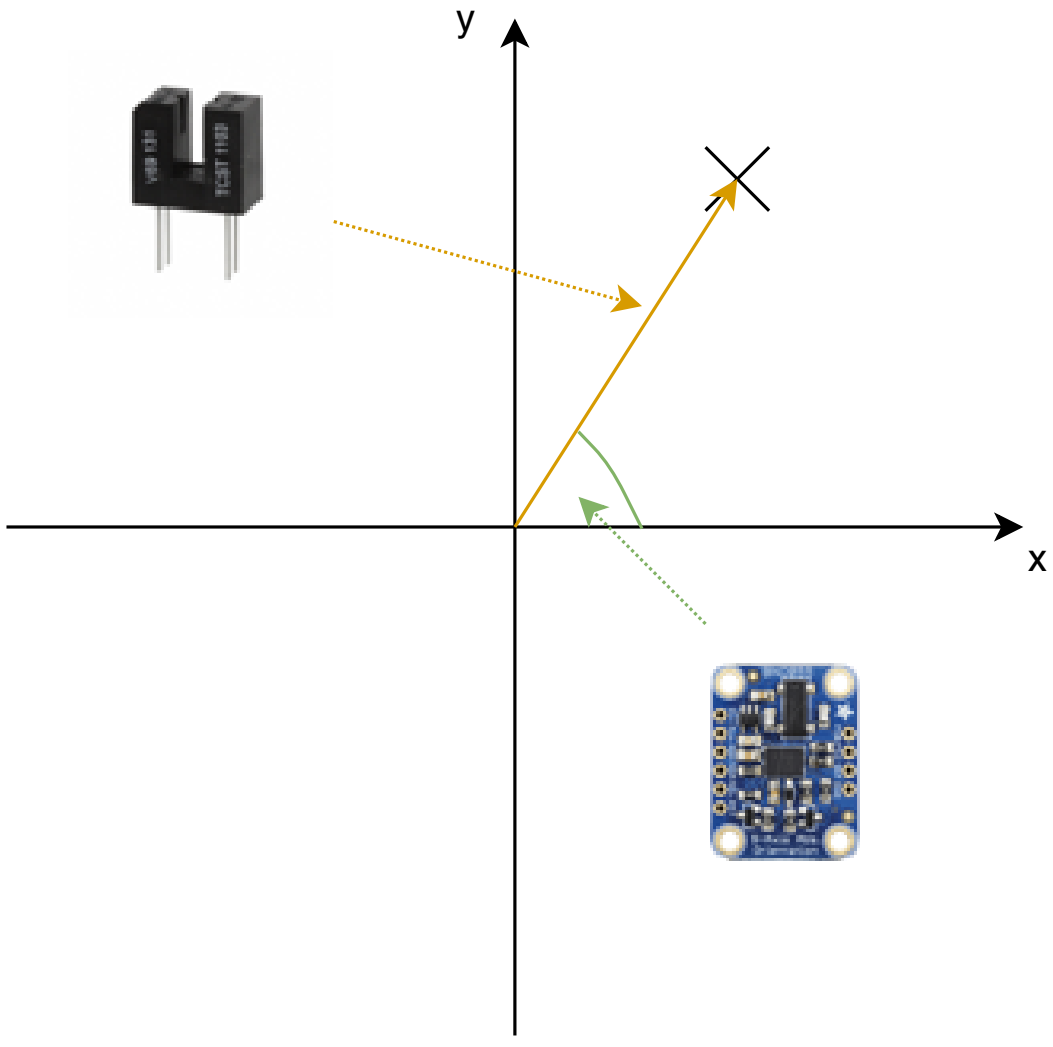
- Revolution Sensor
- Smart movement sensor
- Start point[0,0](x,y)
- Logged position coordinates
  - Calculated with sensor data



Direction of travel
Angle changes

Travel speed

Routing



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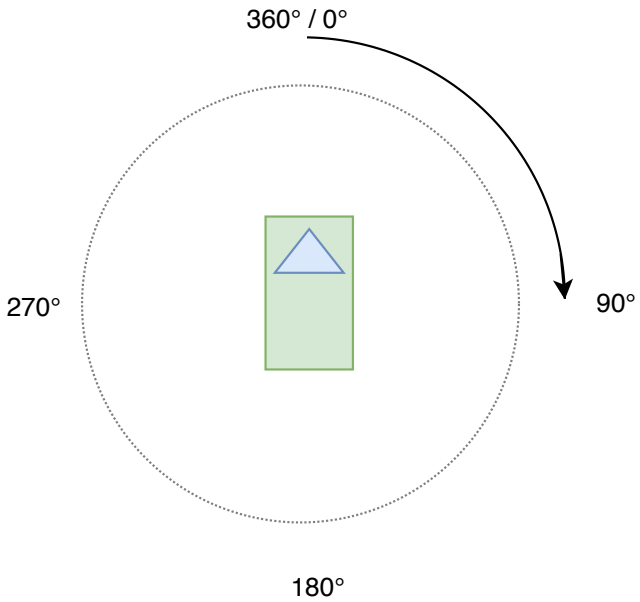

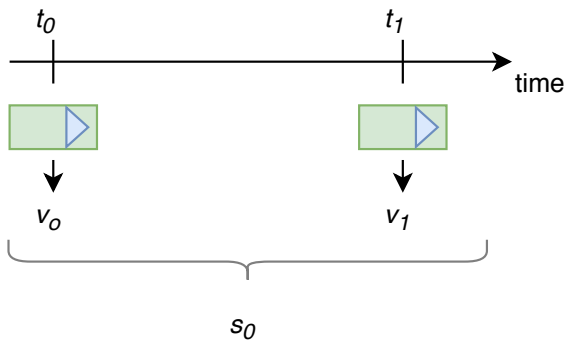

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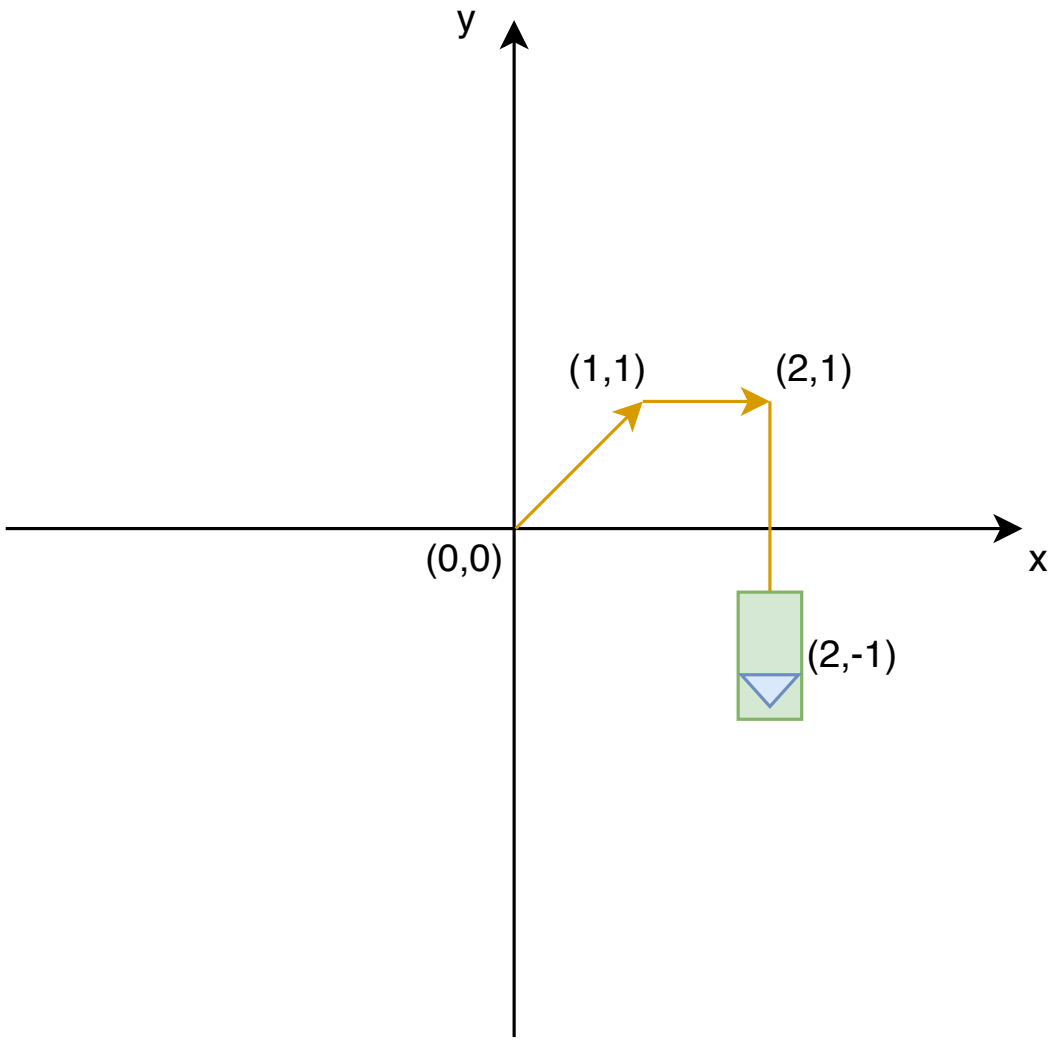
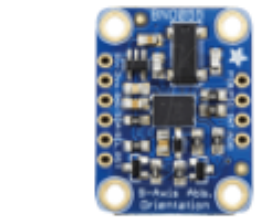


Mapping

- Ultra sonic sensor
- Smart movement sensor
- Related to actual vehicle position and direction of travel
- Logged coordinates of positions of objects
  - Calculated with sensor data



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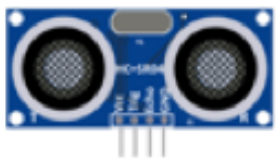
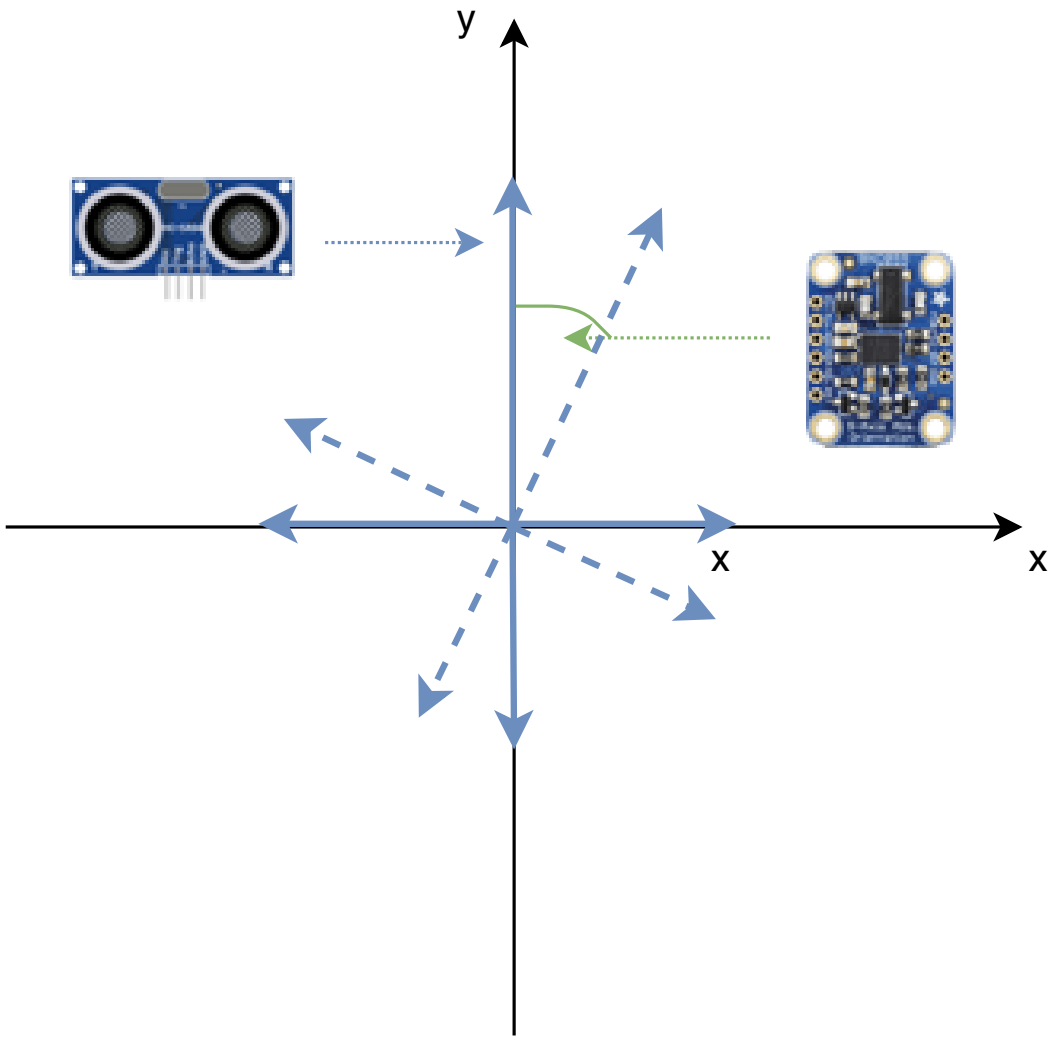


Distance to object

Mapping



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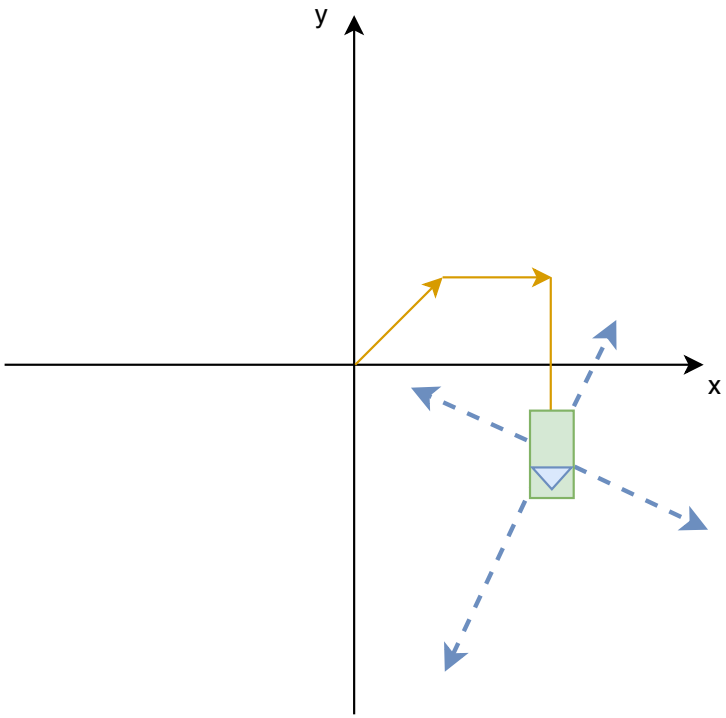
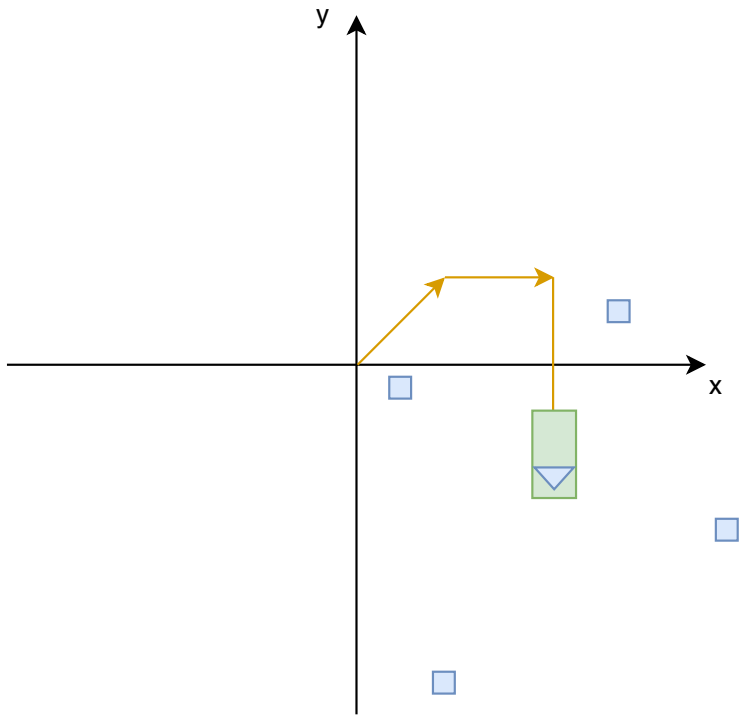
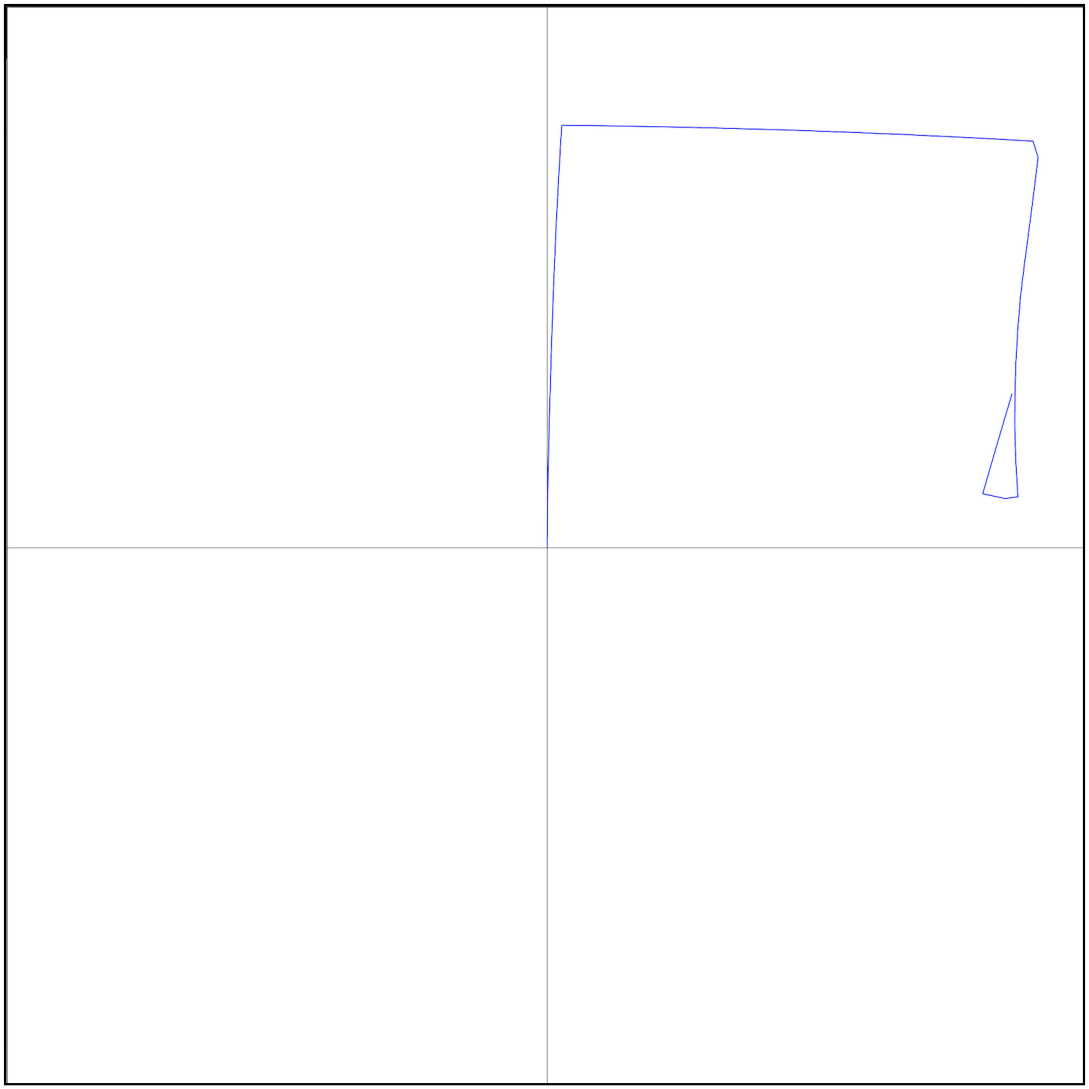




Example



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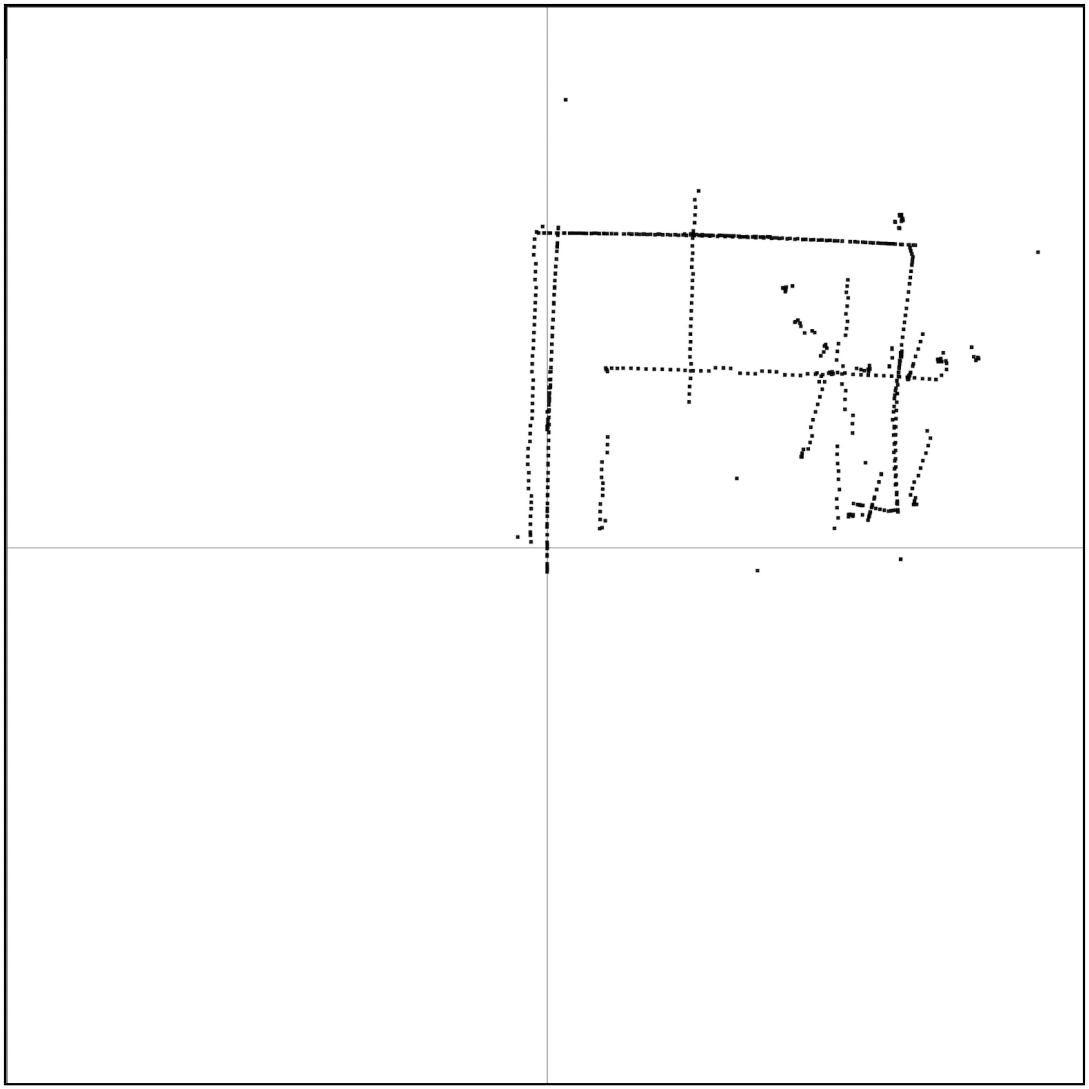

References

- ImageZMQ - `https://github.com/jeffbass/imagezmq`
- Image Processing setup - `https://www.pyimagesearch.com/2019/04/15/live-video-streaming-over-network-with-opencv-and-imagezmq/`
- Tensorflow Modelzoo - `https://github.com/tensorflow/models/blob/master/research/object_detection/g3doc/detection_model_zoo.md`
- SSD - `https://arxiv.org/pdf/1512.02325.pdf`
- MobileNet - `https://arxiv.org/pdf/1704.04861.pdf`
- OpenCV - `https://github.com/opencv/opencv/wiki`

For further information please see the *documentation*