2D Visual Object Detection and Tracking

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Object Detection

- Object detection = classification + localization:
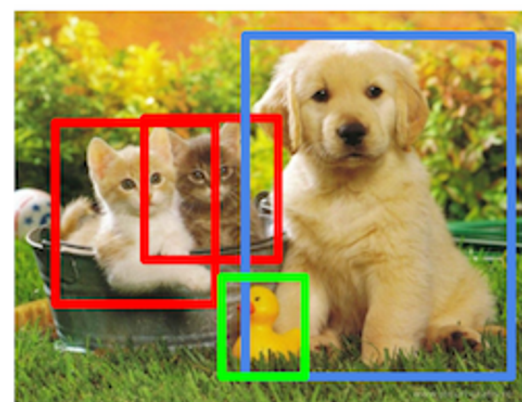- Find **what** is in a picture as well as **where** it is.

Figure: http://cs231n.stanford.edu/slides/2016/winter1516_lecture8.pdf

# Object Detection for UAV sports cinematography

Boat detection.
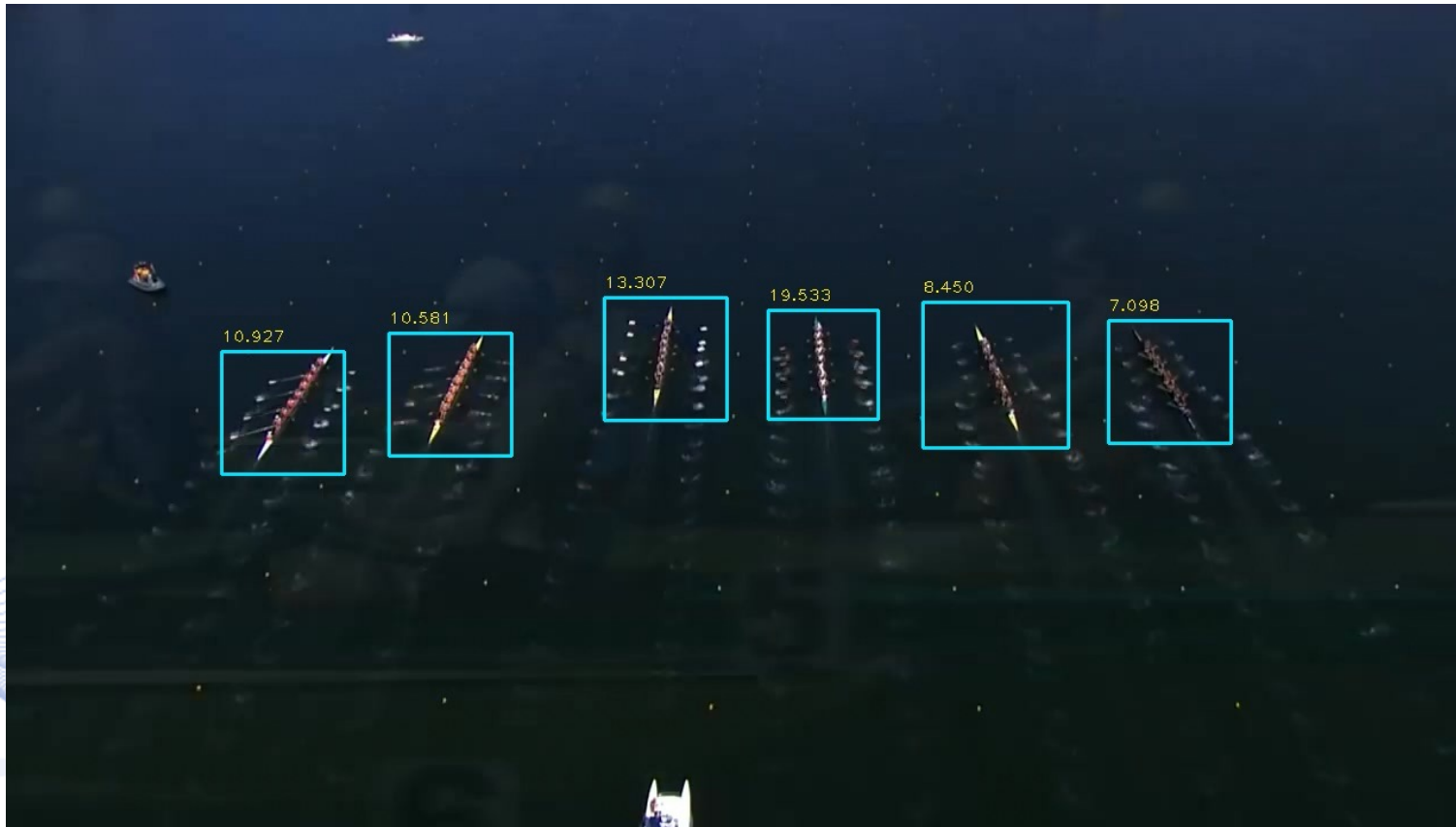
2D Object Tracking

- Video tracking is the process of locating a moving object (or multiple objects) over time using a camera

- Variety of uses:
  - Human-computer interaction;
  - Security and surveillance;
  - Video communication and compression;
  - Traffic control;
  - Medical imaging.

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2D Visual Object Tracking

- Problem statement:
    - To track a target/object (e.g., human face) image in each video frame and localize its *Region-Of-Interest (ROI).*
    - To track the detected object over the video frames.

1st frame   6th frame   11th frame   16th frame
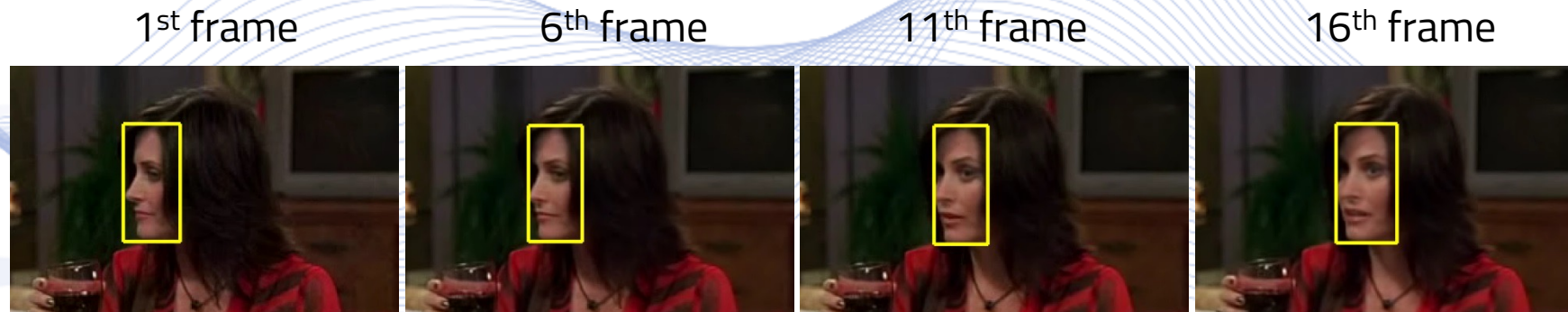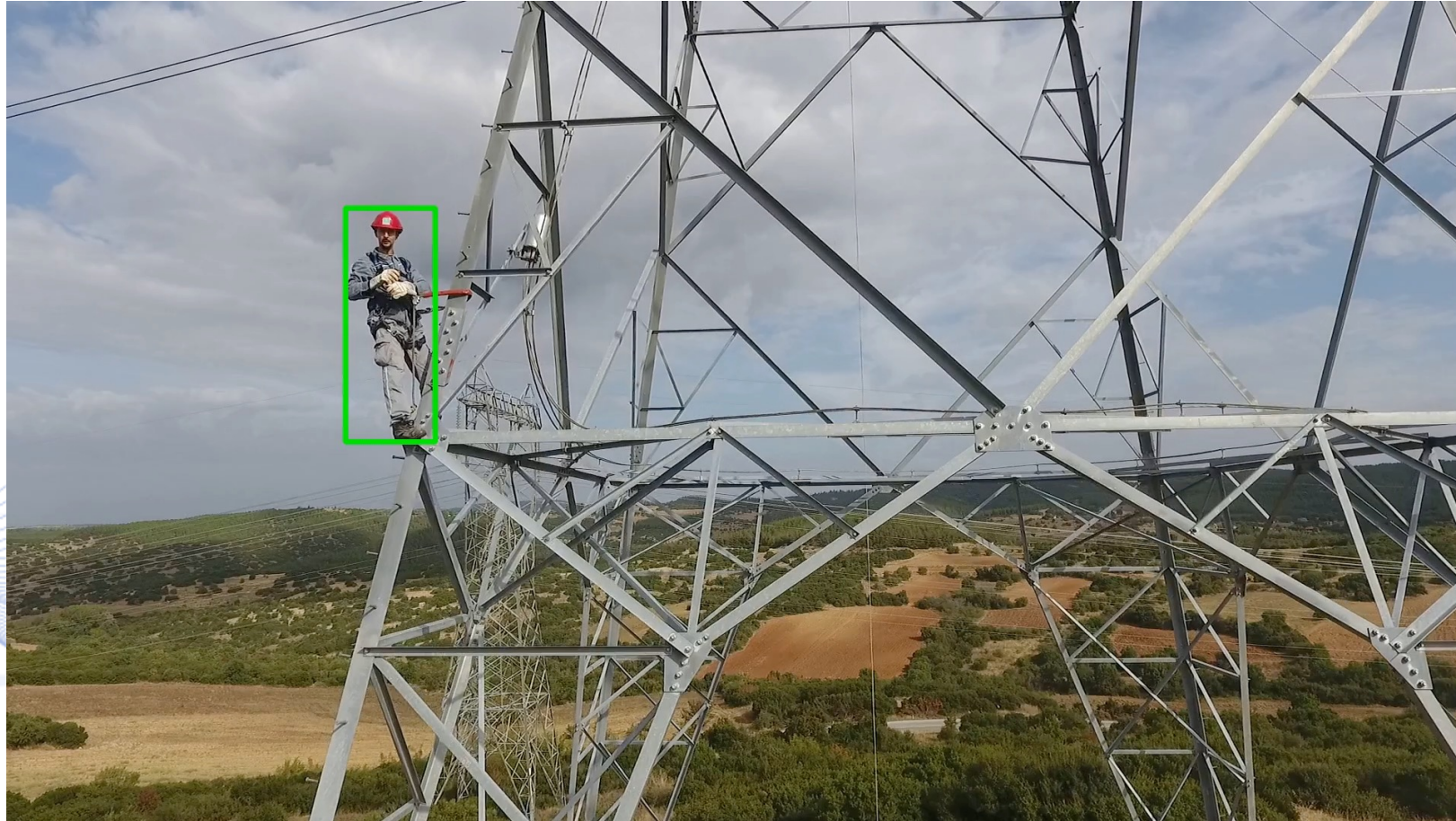
2D Object Tracking

2D Object tracking requirements

- In order to track a moving object, a tracker has to confront:
    - Partial occlusion,
    - Object image deformation,
    - Motion blur,
    - Fast object image motion,
    - Illumination variations,
    - Background clutter.

2D Object Detection and Tracking

```
┌─────────────────────┐
│ Obtain initial video│
│        frame        │
└─────────────────────┘
           │
           ▼
┌─────────────────────┐          ┌─────────────────────┐
│      Detect ROI     │          │      Detect ROI     │
└─────────────────────┘          └─────────────────────┘
           │                                │
           ▼                                ▼
┌─────────────────────┐          ┌─────────────────────┐
│   Train a tracking  │────────▶ │  Obtain next video  │
│        model        │          │        frame        │
└─────────────────────┘          └─────────────────────┘
                                            │
                                            ▼
                          ┌──────────────────────────────────────────┐
                          │ Use tracking model to find new ROI position.│
                          │ Search in a broader area near previous location│
                          └──────────────────────────────────────────┘
                                            │
              NO                            ▼
                                      ◇ End? ◇ ──── YES ──▶ ┌──────────────┐
                                                            │ Stop process │
                                                            └──────────────┘
```
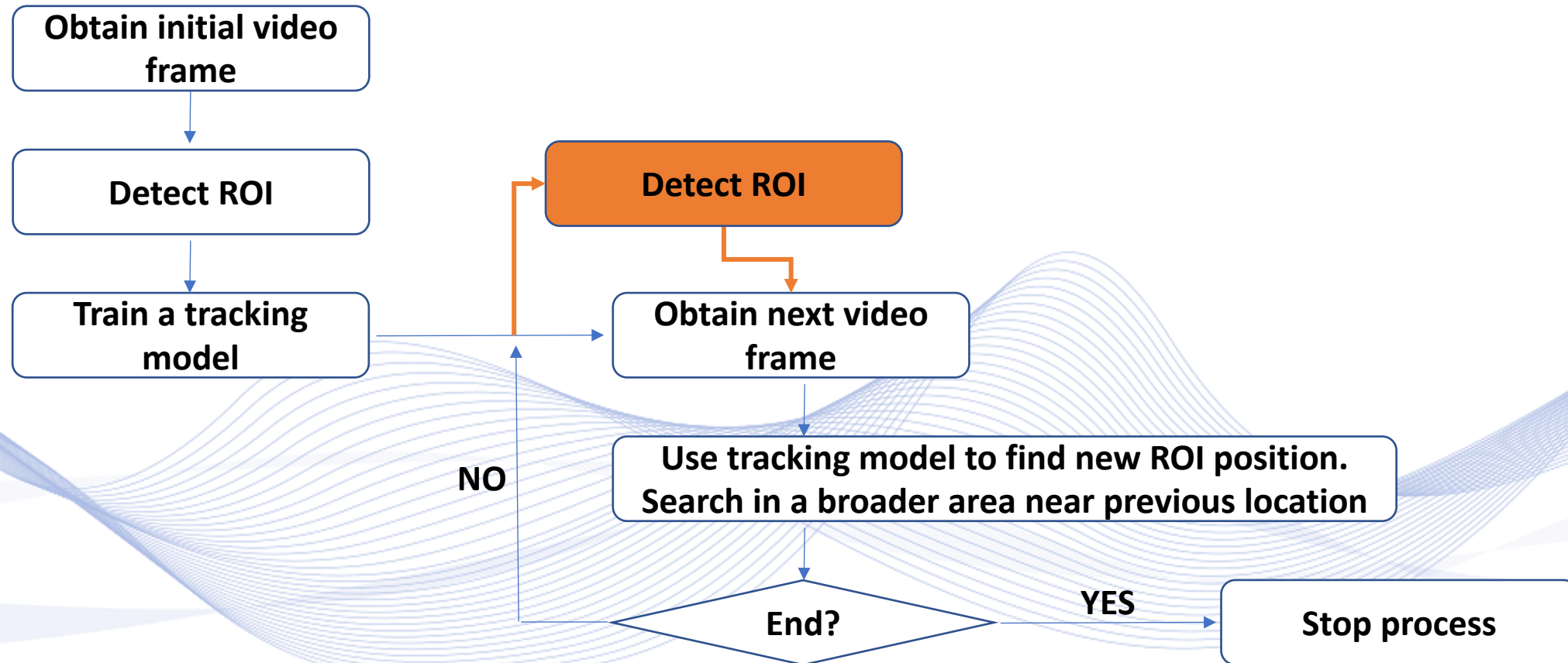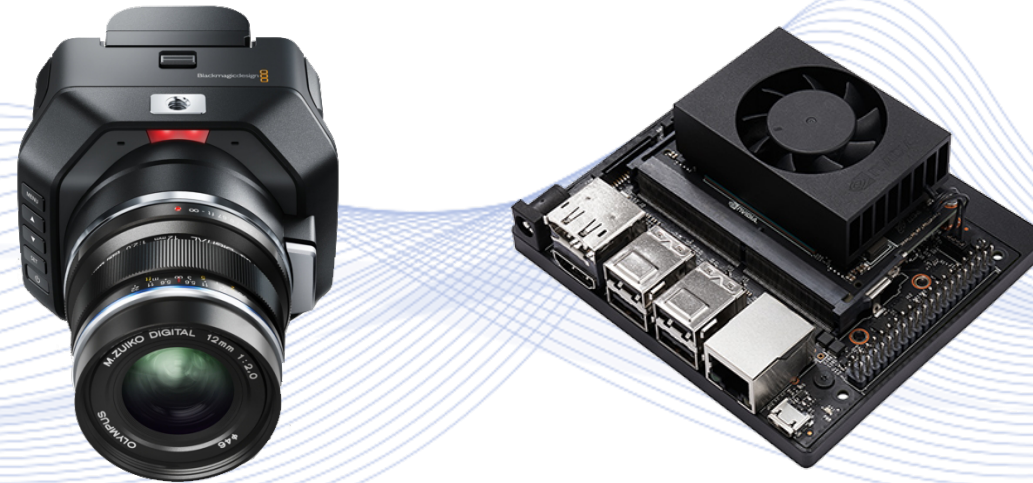
Detection and Tracking in ROS

- Components:
  - Camera,
  - Embedded system (e.g., Jetson TX2/Xavier AGX/NX, Intel NUC, etc.).

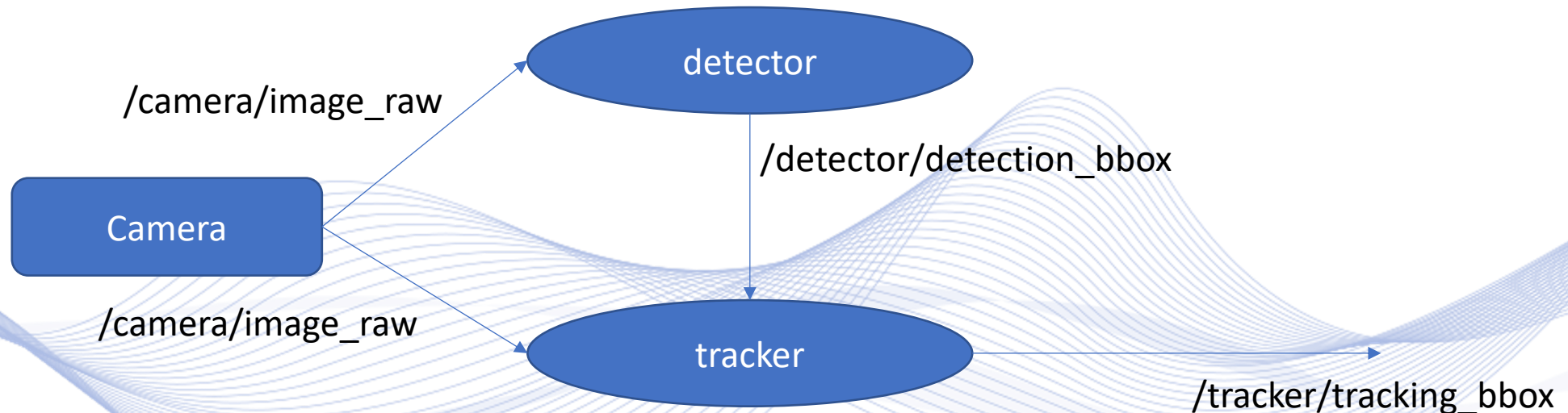*The camera may be connected to Jetson directly via USB/HDMI.*

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ROS

- Robot Operating System(ROS).
- Not actually an Operating System. It is a set of packages that run on Linux.
- Main uses are:
  - communication between hardware parts.
  - communication between software and hardware.
- Some of the most important features are Nodes and Topics.
- Nodes publish messages on topics, or they are subscribed to them to read messages. For example, in our case, a node is subscribed to the topic "camera/Image_raw" and publishes the results to the topic "box_corners".

ROS Nodes: Example on Object Detection

detector

/camera/image_raw

/detector/detection_bbox

Camera

/camera/image_raw

tracker

/tracker/tracking_bbox

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2D Object Detection and Tracking

Q & A

Thank you very much for your attention!

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