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# Chapter 12

## Introduction of Object Detection (Theme 3)

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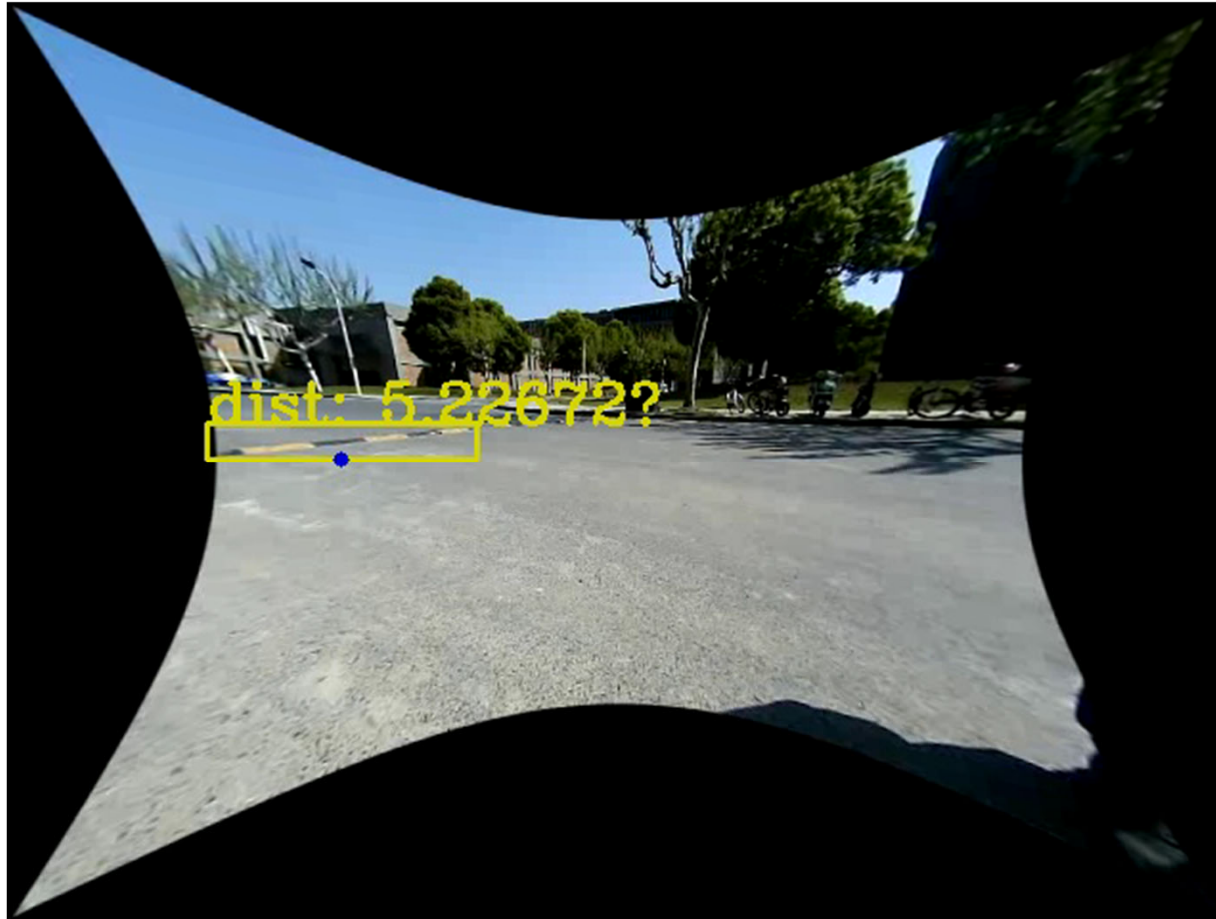
# Problem definition of object detection



Multiple objects detection



## Problem definition of object detection



Perform object detection on each video frame



## Problem definition of object detection

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- Object detection is a fundamental task in computer vision that involves identifying and locating objects within an image or video. This capability is crucial for a wide range of applications, from autonomous driving and surveillance to medical imaging and retail analytics
- Challenges in object detection
  - **Variability in object appearance:** Objects can appear in various shapes, sizes, colors, and orientations
  - **Occlusion:** objects may be partially hidden by other objects, making them difficult to detect
  - **Complex backgrounds:** Cluttered or dynamic backgrounds can interfere with object detection
  - **Real-time processing:** Many applications require object detection to be performed in real-time, necessitating efficient algorithms



# Popular object detection algorithms

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- Traditional Methods
  - Haar Cascades: Used for face detection, relying on handcrafted features
  - HOG (Histogram of Oriented Gradients) + SVM (Support Vector Machine): Effective for pedestrian detection
- Deep Learning-Based Methods
  - R-CNN (Region-based Convolutional Neural Networks): Proposes regions and classifies them using CNNs
  - Fast R-CNN: Improves R-CNN by sharing computation across region proposals
  - Faster R-CNN: Introduces Region Proposal Networks (RPN) for faster processing
  - YOLO (You Only Look Once): A single-shot detector that predicts bounding boxes and class probabilities directly from full images in one forward pass
  - SSD (Single Shot Multibox Detector): Balances speed and accuracy by predicting bounding boxes at multiple scales
  - DETR (DEtection TRansformer): an object detector using a transformer architecture



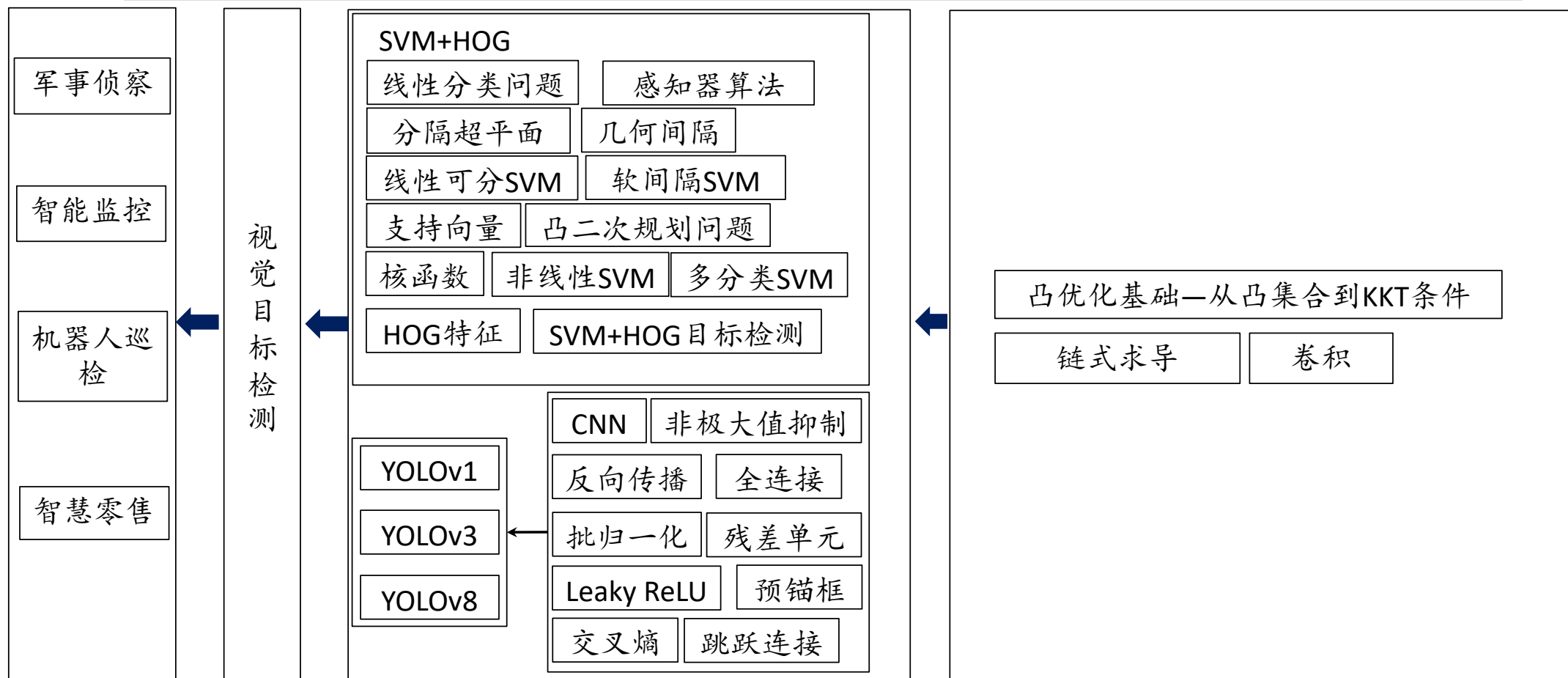
## Contents of this theme

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- ✓ SVM is classical classification approach; to learn it, some knowledge about convex optimization is necessary, which will be covered in Chapter 13
- ✓ SVM+HOG based object detector will be introduced in Chapter 14
- ✓ Fundamental knowledge about CNNs and YOLO will be detailed in Chapter 15



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应用

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## 凸优化基础—从凸集到KKT条件

