



# Distributed Perception by Collaborative Robots

Spotlight Talk

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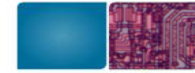
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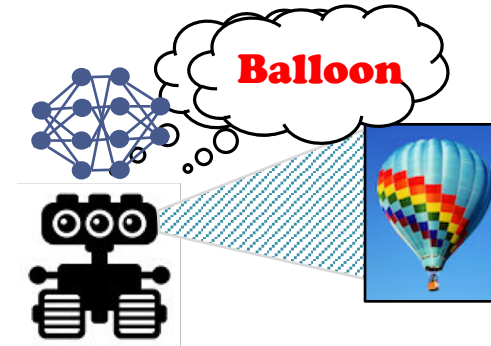


# Deep Learning (DL) and Robots

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- ▶ Robots need process lots of raw data.
  - ▶ Visual, Sounds, Temperature, ...
- ▶ To act, they need to understand their environment.
- ▶ How should they process complex raw data?
  - ▶ Use **deep learning**!



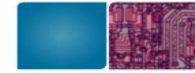


# DL Computation is Heavy

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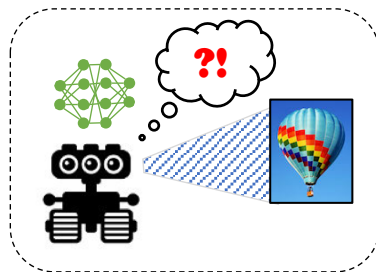
- ▶ But deep neural network are computationally intensive and resource hungry.
  - ▶ Models have large memory footprint.
  - ▶ Latency for single image inference is high.
- ▶ Robots need the result fast and in **real time!**
- ▶ Then how can resource-constrained robots use DL to understand their surroundings?



# Let's Collaborate

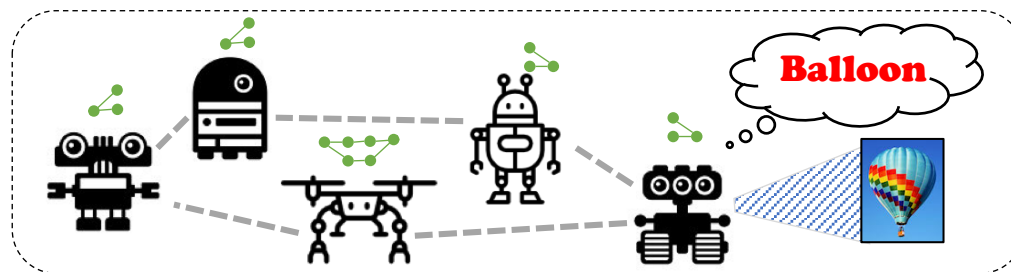
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- ▶ Usually resource-constraint robots share their environment.
- ▶ Not all robots need to perform computations at same time.
- ▶ So what if they share their knowledge and help each other?



Computation Domain

(a) Single Robot



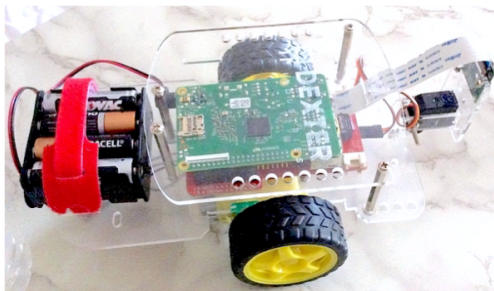
Computation Domain

(b) Collaborative Robots

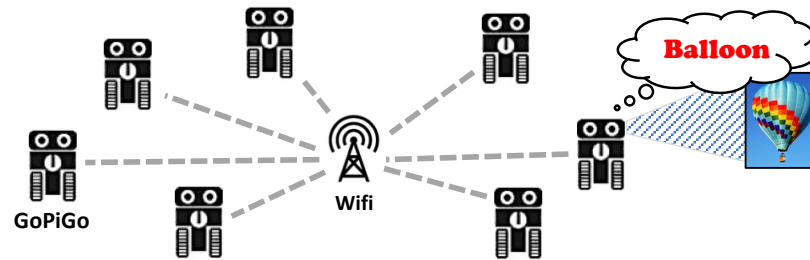


# Our Work Overview

- ▶ We have proposed a technique to efficiently distribute DNN-based models.
- ▶ We also have proposed an algorithm to deploy distributed models onto robots system with **Raspberry Pis**.



(a) GoPiGo Robot

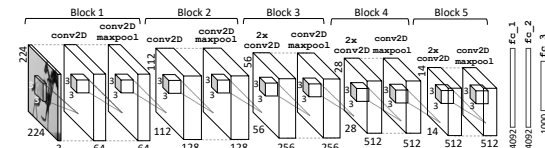
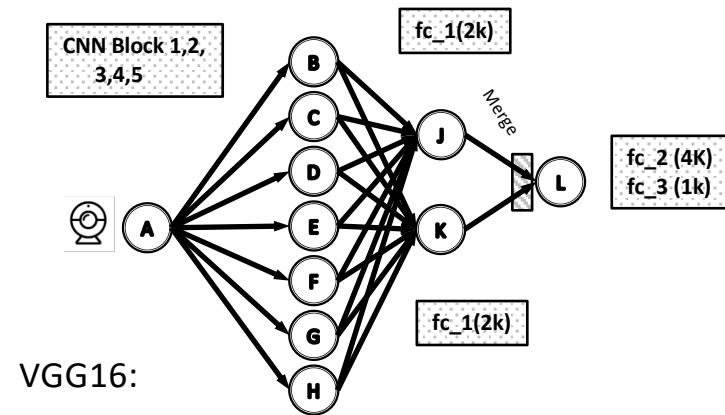
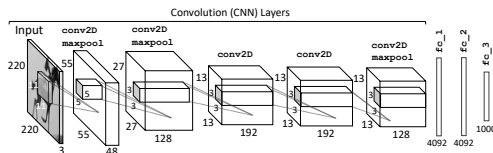
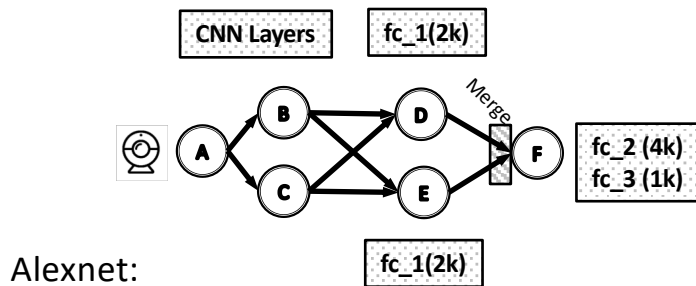


(b) Our Distributed Robot System



# Results

- ▶ We distributed and deployed :
  - ▶ Two image recognition models (VGG16 and AlexNet)
  - ▶ One video recognition model





## Results (Cont'd.)

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- ▶ We successfully deployed the distributed DNN system on up to 12 robots
- ▶ We got comparable results with a high-end embedded GPU platform, Nvidia Tegra TX2
  - ▶ Acceptable inference speed
  - ▶ Better energy consumption