DeepPicar: A Low-cost Deep Neural Network-based Autonomous Car

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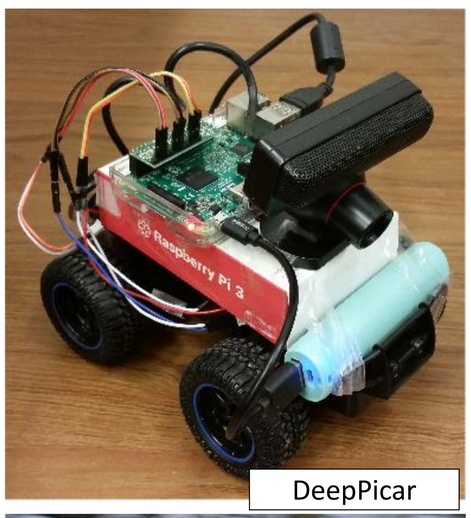
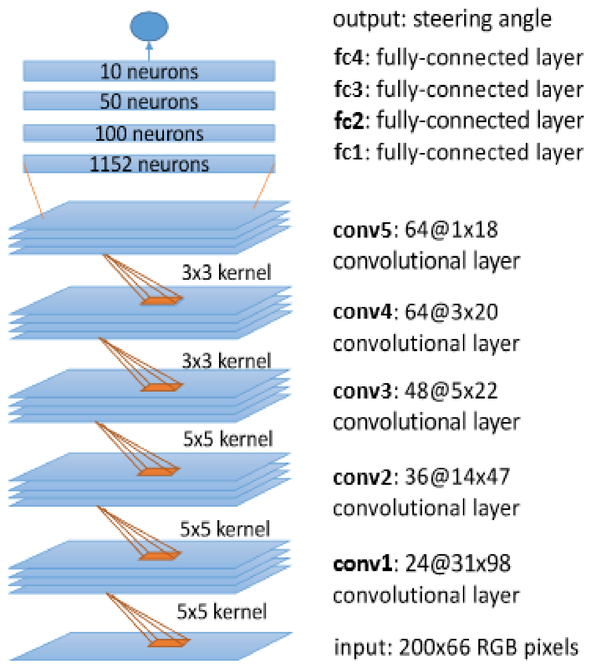
DeepPicar



DeepPicar

DAVE-2



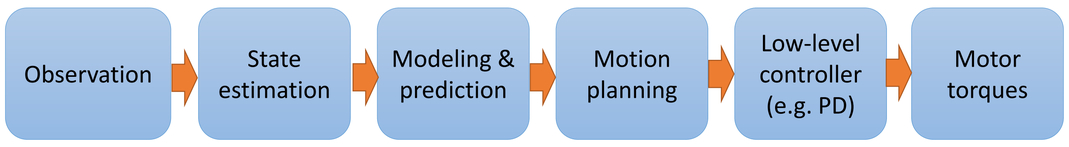
CNN Architecture

- Low-cost autonomous RC car platform using a deep convolutional neural network (CNN) [1].
- Small scale replication of NVIDIA's Dave-2 [2].
- Use **the same CNN**: ~250K weights, ~27M connections.
- Uses Raspberry Pi 3 for real-time CNN inferencing (CPU only).
- Uses python, TensorFlow, and Linux
- Uses affordable components (<$100).

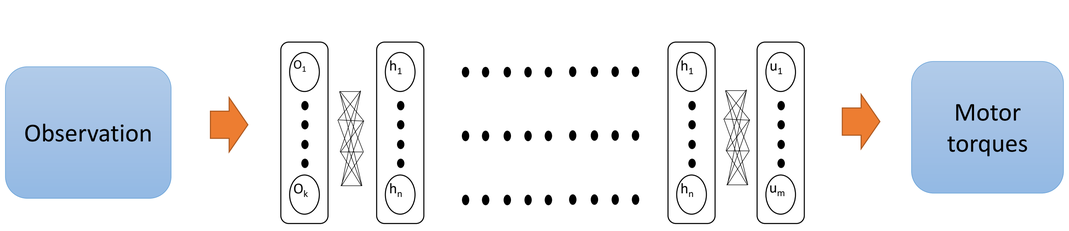
Item	Cost ($)
Raspberry Pi 3 Model B	35
New Bright 1:24 scale RC car	10
Playstation Eye camera	7
Pololu DRV8835 motor hat	8
External battery pack & misc.	10
Total	70

Bill of materials (BOM)

End-to-End Deep Learning-based Control



(a) Standard robotics control approach



(b) End-to-end deep learning approach

- Replace traditional control pipeline with a DNN.

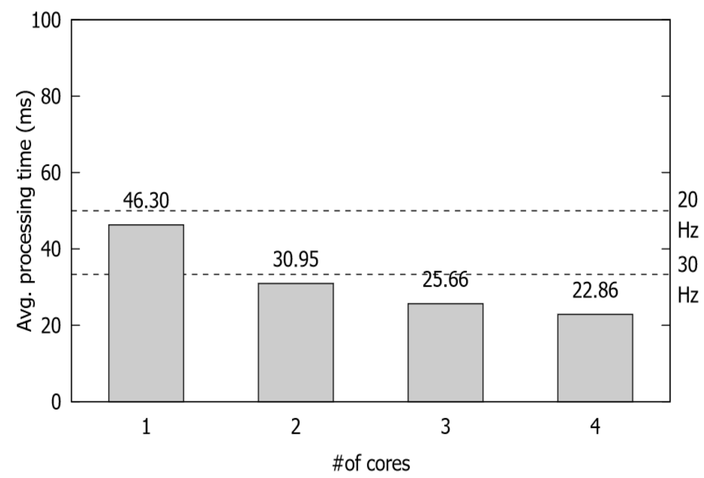
[1] M. G. Bechtel, E. McEllhiney, M. Kim, and H. Yun. Deeppicar: A low-cost deep neural network-based autonomous car. In *IEEE International Conference on Embedded and Real-Time Computing Systems and Applications (RTCSA),* 2018.
[2] M. Bojarski et al. End-to-End Learning for Self-Driving Cars. *arXiv:1604*, 2016.

Real-Time Control Loop

```
while True:
  # 1. read from the forward camera
  frame = camera.read()
  # 2. convert to 200x66 rgb pixels
  frame = preprocess(frame)
  # 3. perform inferencing operation
  angle = CNN_inferencing(frame)
  # 4. motor control
  steering_motor_control(angle)
  # 5. wait till next period begins
  wait_till_next_period()
```

- Simple control loop implementation

Real-Time Performance



- >20 Hz using just one Cortex-A53 core
- >30 Hz using two cores.

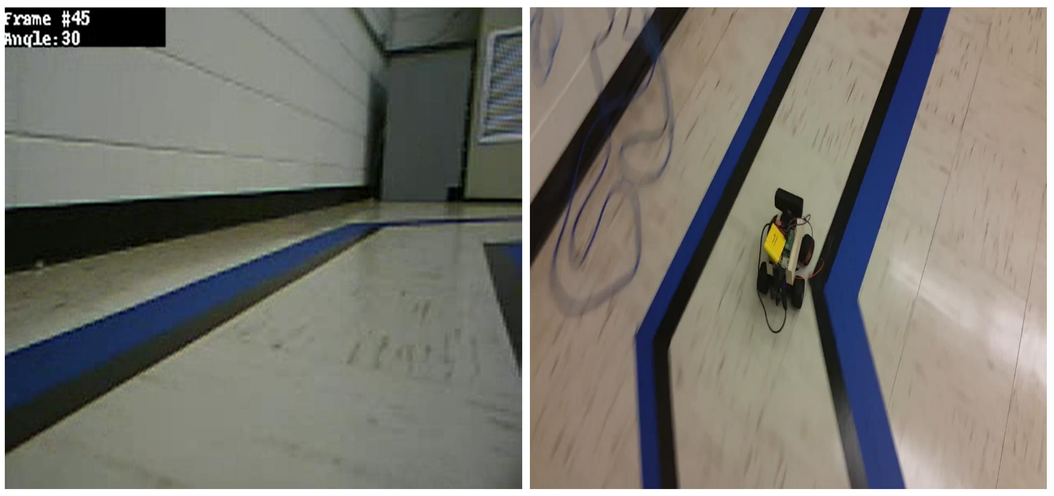
Use Cases

- Research
  - DeepPicar's CNN workload can be used as a representative **real-world benchmark** workload.
- Education
  - DeepPicar can be used for student projects (both University and K-12) to have hands on experiences at a much lower cost.

Availability

- Source code, building, videos, and operating instructions: https://github.com/mbechtel2/DeepPicar-v2

Demonstration



- First and third person perspectives of DeepPicar driving autonomously.

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