

Computer vision used for alertness detection

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Presentation layout

- Project introduction
- Artificial Intelligence
- Tools
- Project
- Demonstration

Introduction

Two main concerns:

- Driver drowsiness ¹:
 - 72,000 crashes
 - 44,000 injuries
 - 800 deaths
- Use of self phone while driving ²
11% of crashes

¹source: CDC (US, 2013)

²source: WHO (US, 2005-2007)

A real need to combat driver distraction
through the growth of embedded technologies using:

- Computer vision
- Neural networks

Artificial Intelligence

- Recreating the human eye

Modern CCD sensors more sensitive than a human eye

- Recreating the human brain to interpret the output

Underlying software at the heart of computer vision

Image interpretation

Our brain is built with vision in mind

Sense for which it allocates the most processing power

- groups of neurons excite each other when contrast or motion is detected
- higher level neurons aggregate this in meta-patterns i.e. A circle moving upwards
- other groups recognize colors

The brains paints a mental picture

Computer vision: Top-down vs. Bottoms-up (1)

- Top-down approach: **Naive approach**
- Tell the computer: this is what a book looks like
What if the book is on its side?
- Requires to store pictures of every object in every configuration and from every angle

Computer vision: Top-down vs. Bottoms-up (2)

- Bottom-up approach: **Smarter approach**
- Apply transformation to objects to detect edges
Through math and statistics match to a trained dataset
- Similar to what the brain achieves

- Techniques to give computer systems the ability to “learn”

“Learning is the human process that allows us to acquire the skills necessary to adapt to the multitude of situations we encounter.”

[Japkowicz and Shah (2011)]

Machine learning: Neural networks

- Learning systems inspired by the human brain
- Cluster of neurons linked together
 - Optimized by adjusting links' weights*
- Supervised learning with a labeled dataset

Tools

- Open source library with thousands of algorithms for:
 - Detect and recognize faces
 - Identify objects
 - Track movements
 - Etc...
- Strong focus on real-time applications
- Free for use under the open-source BSD license ³
- Supports deep learning frameworks
TensorFlow, Torch/PyTorch and Caffe

³License imposing minimal restrictions on the use and redistribution of covered software

- Caffe: Convolutional Architecture for Fast Feature Embedding

Deep learning framework

- Open source under BSD license
- Written in C++ *with a Python interface*
- Lots of pre-trained model available for free
<https://github.com/BVLC/caffe>

Project

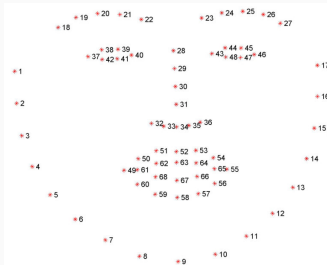
Features (1)

- Object detection:
 - Face
 - Eyes
 - Cellphone
- Alert on abnormal behavior

Features (2)

- Face and eyes recognition

Using Top-down approach



- Cellphone detection

Using Bottoms-up approach

Image from *pyimagesearch.com*

Integration of tools

- OpenCV to detect object on video stream
- **.DAT** file as face landmarks
- Caffe pre-trained model as cellphone detector
- All included on Python simple application

How does it works (1)

- Attempt to detect objects on each frame:
 1. A face
 2. Eyes
 3. A cellphone
- Face and eyes are compared with the **.DAT** file
- Computing eyelids distance to detect closed eyes
- Neural network to detect labeled foreign objects

How does it works (2)

Alert when:

- No face detected
- Eyes closed for too long
- Foreign object recognized as a cellphone

Python3 with options:

- **-s, --shape-predictor** Face landmarks (**.DAT** file)
- **-p, --prototxt** Caffe *deploy* prototxt file
- **-m, --model** Caffe pre-trained model
- **-l, --label** Text file linking Caffe labels to text
- **-a, --alarm (optional)** Alarm **.WAV** file

Improvements

- No just "Alert" the driver
- More input parameters
Heart rate, breathing, ...
- Embedded system
- Own neural network

Thank you!

Do you have any questions?

A video demo is ready!

- https://link.springer.com/chapter/10.1007/978-3-642-21729-6_80
- <https://www.pyimagesearch.com/2017/05/08/drowsiness-detection-opencv/>
- <https://www.pyimagesearch.com/2017/08/21/deep-learning-with-opencv/>
- <https://techcrunch.com/2016/11/13/wtf-is-computer-vision/>

- http://www.who.int/violence_injury_prevention/publications/road_traffic/distracted_driving_en.pdf
- <https://www.cdc.gov/features/dsdrowsydriving/index.html>
- <https://opencv.org>
- <http://caffe.berkeleyvision.org>