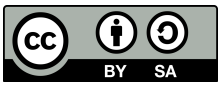
ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA DE TELECOMUNICACIÓN

GRADO EN INGENIERÍA EN SISTEMAS DE TELECOMUNICACIONES

TRABAJO FIN DE GRADO

Deep Learning on TensorFlow

Autor: Ignacio Condés Menchén
Tutor: José María Cañas Plaza
Curso académico 2017/2018



Chapter 1

Introduction

Here, we will talk about current robotics applications, which can be really useful at daily tasks. These tasks are of greater interest when the behavioral of a robot tends to emulate the human one (without the human body limitations). This requires a polished (and somehow complex) behavioral.

But, almost every time, a behavioral is a reactive response, triggered by a certain input (typically perceived by on-board sensors, among others). This raw data is generally mapped into a concrete response. At this point, we can take much benefit from *Neural Networks*, which can yield a really effective, fast and **strong** response, specially when we are dealing with image processing.

There are several processing tools based on Neural Networks at the JdeRobot robotics platform (Detection Suite, TFG David, Nuria, PFC Roberto Calvo [this one does not implement NNs]), which as we have just mentioned, can make such a brilliant tandem along with a reactive behavioral.

As we will be able to see later, **robotics + deep learning rocks!**

Chapter 2

Infrastructure

2.1 Python 2.7

2.1.1 `threading` library

2.2 TensorFlow

2.2.1 CUDA

2.3 Keras

2.4 JdeRobot

2.4.1 `comm`

2.4.2 `PyQt5`

2.4.3 Digit Classifier

2.4.4 Detection Suite

2.5 OpenCV

2.6 ROS

2.6.1 OpenNIServer

2.7 Hardware

2.7.1 Asus Xtion

2.7.2 Turtlebot / Kobuki

2.7.3 Sony EVI D100P

Chapter 3

Objectives and Methodology

3.1 Objectives

With all this in mind, the objective of the present work has been to get a little further on **deep learning applied to robotics**, developing two sucessive components.

3.1.1 Detection: `ObjectDetector`

As it will be described on the suitable chapter, we have built a component (`Object Detector`) which implements **a generic object detection structure** on an image. This component is ready to work in *real time* (processing a streaming video flow).

3.1.2 Reactive behavioral: `FollowPerson`

The next milestone was to be able to connect this intelligent perception to a reactive behavioral, translated into a robot following a certain person. This requires of two main abilities:

- Object detection and discrimination: this is just what we achieved with the previous component. We only have to constrain the detections to only keep persons.
- People reidentification: as it will be seen, the component is able to track a certain person (which is called *mom*). This is achieved with a person-by-person face comparison with a reference face (which belongs to *mom*). This process is performed by a *siamese neural network*, which is inspired by [tfm marcos pieras].

With these capabilities, we can perform a neural control over physical actuators. Its main avail is the significant strength that a *convolutional neural network* can keep on variable light conditions, which is the main Damocles sword on the image processing field.

3.2 Methodology

3.2.1 TensorFlow Convolutional Neural Network (*CNN*)

SSD Detector

Network Architecture

Load of different models

Chapter 4

Object Detector

4.1 Description

4.2 Functional architecture

4.3 Neural Network processing

Chapter 5

Follow Person

5.1 Description

5.2 Functional architecture

5.3 Neural Network processing

5.4 Face detection and identification

5.5 Tracking algorithm (physical response)

Chapter 6

Conclusions

Chapter 7

Future research lines

Chapter 8

Bibliography