

# Ball detection system for a humanoid robot

Bartosz Bok

Automatic Control and Robotics

Academic year 2019/2020

Supervisor: dr inż. Andrzej Kordecki

## 1. Introduction

Artificial intelligence is an area of knowledge that is growing at an ever faster rate. Many scientists and engineers are working on its development, since it is a science including computer science, mathematics and robotics. It also covers many departments related to biology/evolution, because its operation simulates the behavior of intelligent beings. Its applications can be seen in many aspects of our lives. One of them is the vision system.

In this diploma the deep learning method is used to ball detection for the robot "Melson". It is a humanoid robot which is being prepared in the Students' Robotics Association for football competitions, hence the need to be able to find out the location and distance to the ball based on the image from the camera.

## 2. Mathematical model

### Assumptions and main objectives

Artificial Intelligence is modeled on the action of biological neurons, creating a network capable of learning.

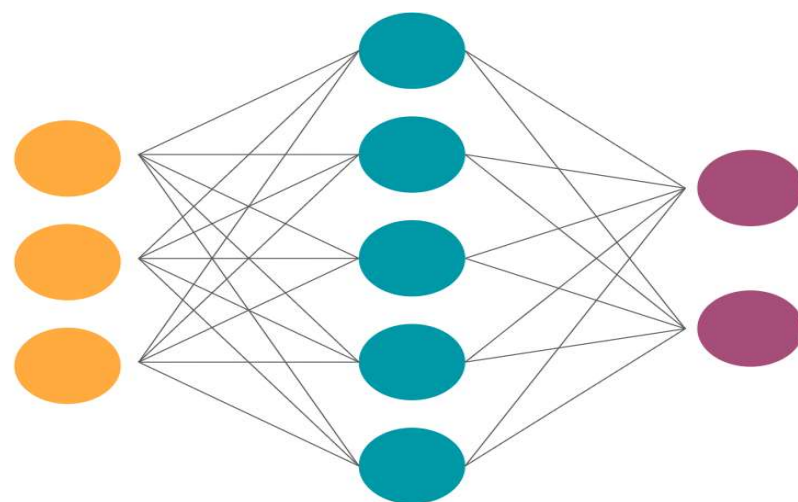


Figure: Neural network model

The neural network consists of an input layer, an appropriate number of hidden layers and an output layer. The input layer is photos and the output layer is the probabilities of location of the object in a given place. Hidden layers are automatically created by the network without our control and are quite abstract.

This neural network uses a backward propagation algorithm for learning. Based on many images of the object, the network changes the weights between neurons accordingly, creating strong or weak relationships between them.

The learned network can properly analyze the image and indicate the place where the searched object can be.



Picture: Detected ball in the picture

## 3. Used models

This method uses the SSD Mobilenet convolutional network model which is considered one of the fastest methods. The input data was less than 1000 photos depicting the ball in various places, distances and in changing light. The learned neural network can recognize the ball with an accuracy of approximately 90%. Melson will look for a ball with a frequency of 2 Hz.

Robot Melson will be equipped with an Intel NUC computer which has good parameters, but we should watch over the use of computing power, as the humanoid will also perform other functions. Detection of the ball is quite costly with respect to computation, so after finding the ball, its position and frame size will be transferred to an algorithm based on OpenCV, which can track the object much faster and less costly.

## 4. Conclusions

- Artificial intelligence can be increasingly used in robotics, for example in computer vision
- With the right approach to learning the neural network, a robot can recognize many things with good accuracy
- Using two cameras can also determine the distance to objects, so distance sensors may be useless in the future