IntelliSys 2020
3-4 September 2020 | Amsterdam

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A LOW COST VISUAL SENSOR FOR GESTURE RECOGNITION VIA AI CNNS

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Abstract

One of the possible ways that prosthetics can become smarter is with the use of Artificial Intelligence (AI): this area in computer science is growing massively as the number of useful applications that stem of AI are endless

Here we propose an AI intelligent system that react and learn as humans combined with prosthetics: smart prosthetic can recognize **(1) hand gesture** and **(2) daily life objects** and react accordingly without the user having to interact with the device through biomedical signals

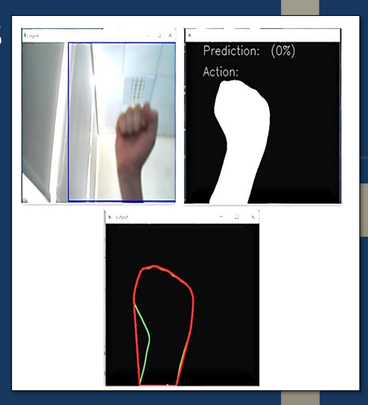
Aims and objectives

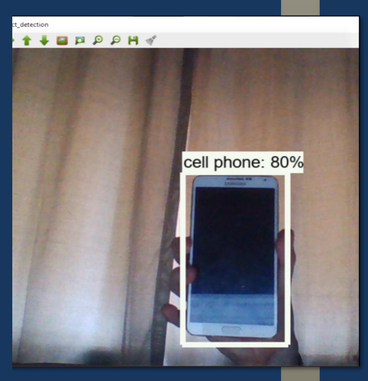
- Literature overview with focus on what other researchers have done and how AI has already blended with prosthetics
- Critical review of the different methods of controlling a prosthetic device vs AI
- Development of an AI system based on Convolutional Neural Networks with Tensor Flow
- Results and discussion

Materials & Methods

Two projects that employ different AI's in order to achieve object detection in real-time

- Research techniques for controlling prosthetics
- Discuss Convolution Neural Networks (CNN's)
- Development of a **Gesture Detection** & recognition system with VGG-16 model (i.e. sending the image through a stack of convolution layers and then a filter with small receptive field to capture all of the image)
- Development of an **Object Detection** & recognition system using YOLOv2 model (i.e. single NN trained end to end that takes an image as inputs and predicts bounding boxes and class labels for each bounding box)





Results

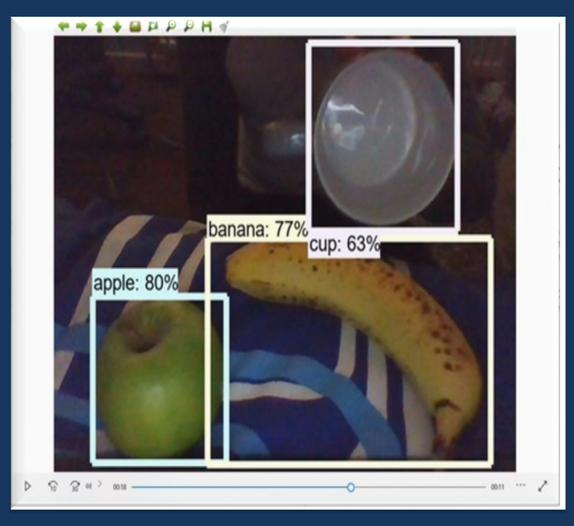
Tables and Figures report some feasibility tests which were performed in order to validate the system and check its reliability

Gesture project overall accuracy test					
Test Number	Palm	Fist	Peace	L	Okay
1	87%	100%	93%	100%	100%
2	75%	90%	80%	69%	80%
3	88%	93%	77%	73%	74%
4	98%	81%	68%	71%	84%
5	74%	89%	82%	87%	90%
Average score	84.4%	90.6%	80%	80%	85.6%

Table 1 - Overall accuracy of all five gestures.

Object project overall accuracy test (single objects)					
Test number	Book	Phone	Scissors	Apple	Banana
1	81%	80%	69%	57%	74%
2	85%	95%	79%	66%	69%
3	78%	82%	61%	73%	59%
4	95%	72%	81%	86%	86%
5	73%	77%	83%	69%	74%
Average Score	82.4%	81.2%	74.6%	70.2%	72.4%

Table 2 - Table of accuracy for object project. (Single objects)



The figure shows two results from the projects: in the top-left panel is the object project with multiply detections and recognition; top-right panel reports the gesture project with researcher performing recognised hand gesture.

Summary

Both systems have shown that the use of AI and prosthetics together are key in order to achieve smarter prosthetic as they far surpass any prosthetic device without AI assistants. The systems should now be implemented and coupled with a real prosthetic hand in order to perform a proper validation.

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This work was presented in dissertation form in fulfillment of the requirements for the Master of Robotics for the student Daniel McHugh under the supervision of Dr. Emanuele Lindo Secco from the Robotics Laboratory, School of Mathematics, Computer Science and Engineering, Liverpool Hope University.