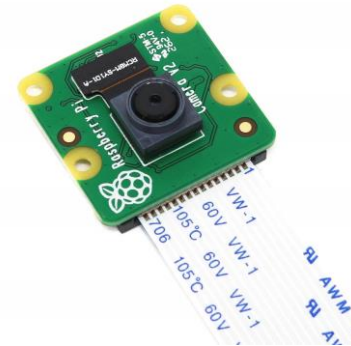
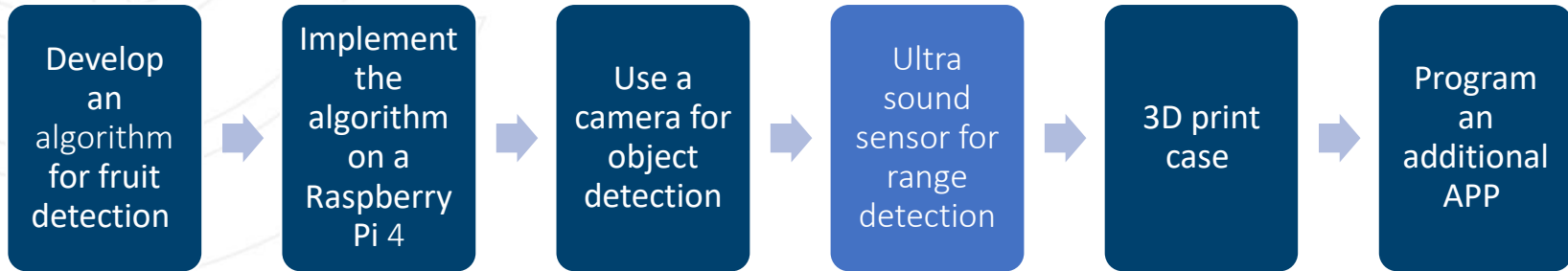


Fruit and vegetable recognition device for the visual impaired **final results**

Leo Huber, Leonhard Wagner,
Hendrik Wenzel



Project Idea

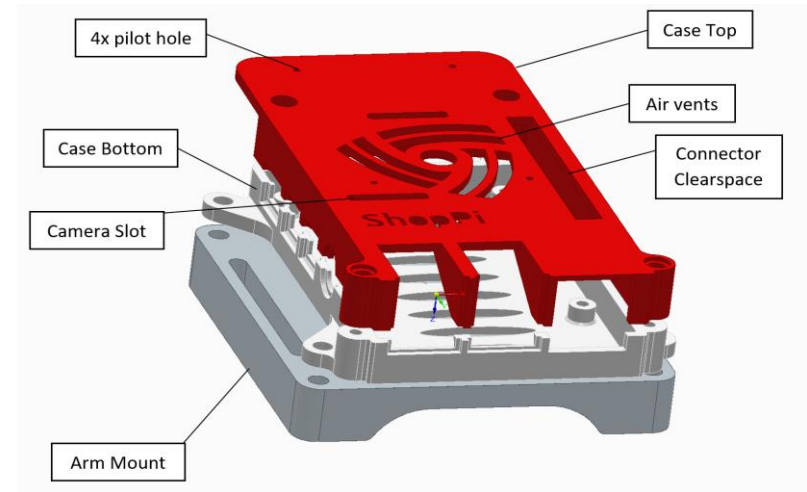
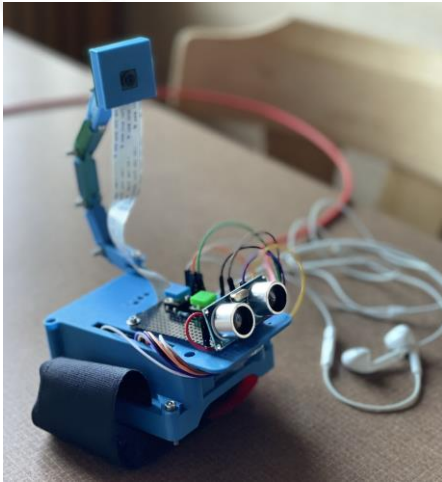


Project Design

- Find a suitable data set to train a neural network
- Train the neural network on data
- Develop a portable case for the Raspberry Pi
- Mount the camera
- Integrate the Raspberry with the App via Mqtt

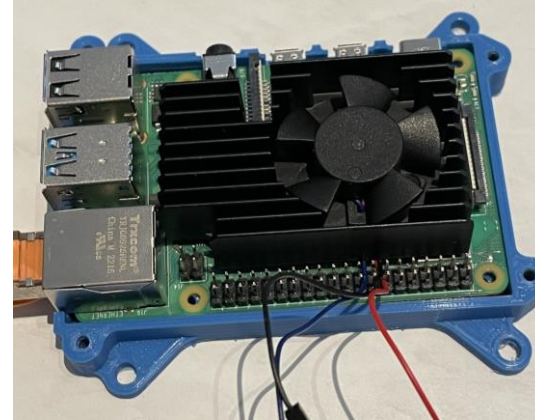
Hardware Implementation

- The mount was designed in several parts
- Ultrasonic sensor on circuit board on top of case
- Connection to the wrist by Velcro straps + headphones and power supply



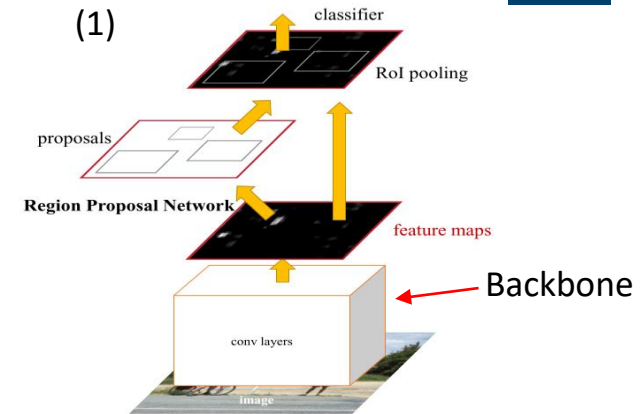
Hardware Implementation

- Problem: Raspberry Processor gets hot after running the algorithm for a longer time => processor throttling reduces power
- Solution: Cooling Fan implemented on top of chip, Case was redesigned to fit the fan

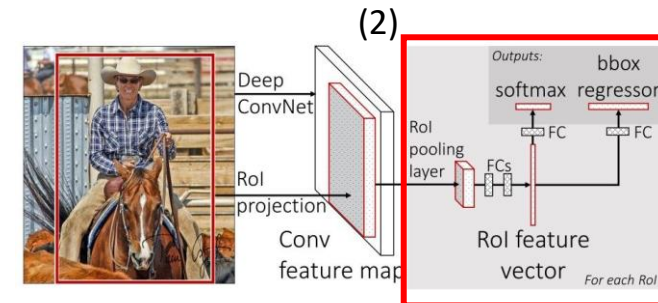


Software Implementation

- Used object detection algorithm: Faster R-CNN
 - Consists of 2 different stages:
 - Region Proposal Network: Image features are extracted and after a scan the likelihood of an existing object is calculated
 - Classification and Bbox regression of Regions of Interest
- CNN: MobileNetV3 is used as backbone network
- Pretrained network refined with open source data set for object detection (Microsoft COCO = 123k images)
 - Only relevant pictures (apple, oranges, ...) were taken (consists of 6827 pictures)
 - After (just) 2 epochs the best model exists



Source: Ren, Shaoqing, et al. "Faster r-cnn: Towards real-time object detection with region proposal networks." *Advances in neural information processing systems* 28 (2015): 91-99.

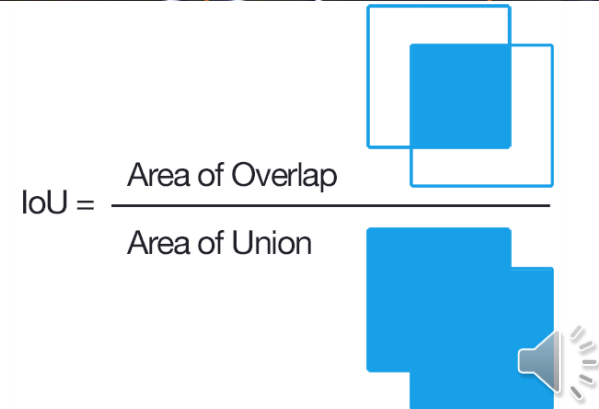
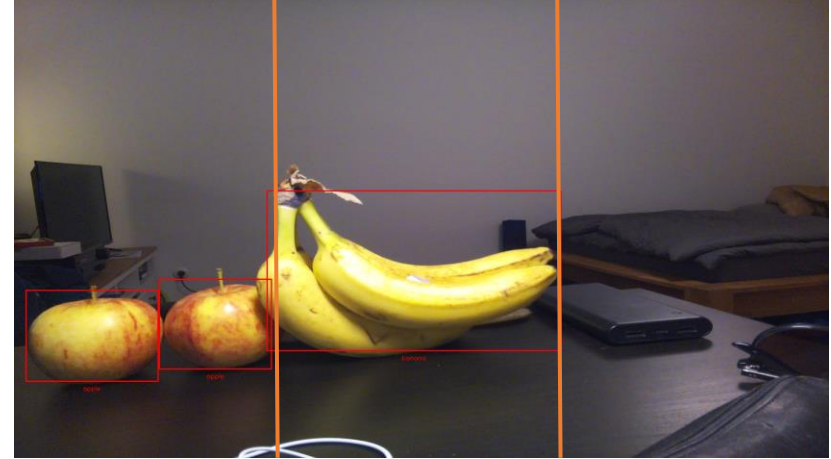


Source: Ren, Shaoqing, et al. "Faster r-cnn: Towards real-time object detection with region proposal networks." *Advances in neural information processing systems* 28 (2015): 91-99.



Software Implementation

- Faster R-CNN locates (with rectangular bounding boxes) and classifies the object
- Intersection over Union (IoU) is used to locate the majority of the objects in three different image areas
 - Left, middle and right
- Also used as: Evaluation metric to measure the accuracy of object detection



Source: <https://pyimagesearch.com/2016/11/07/intersection-over-union-iou-for-object-detection/>

Key:



= Input



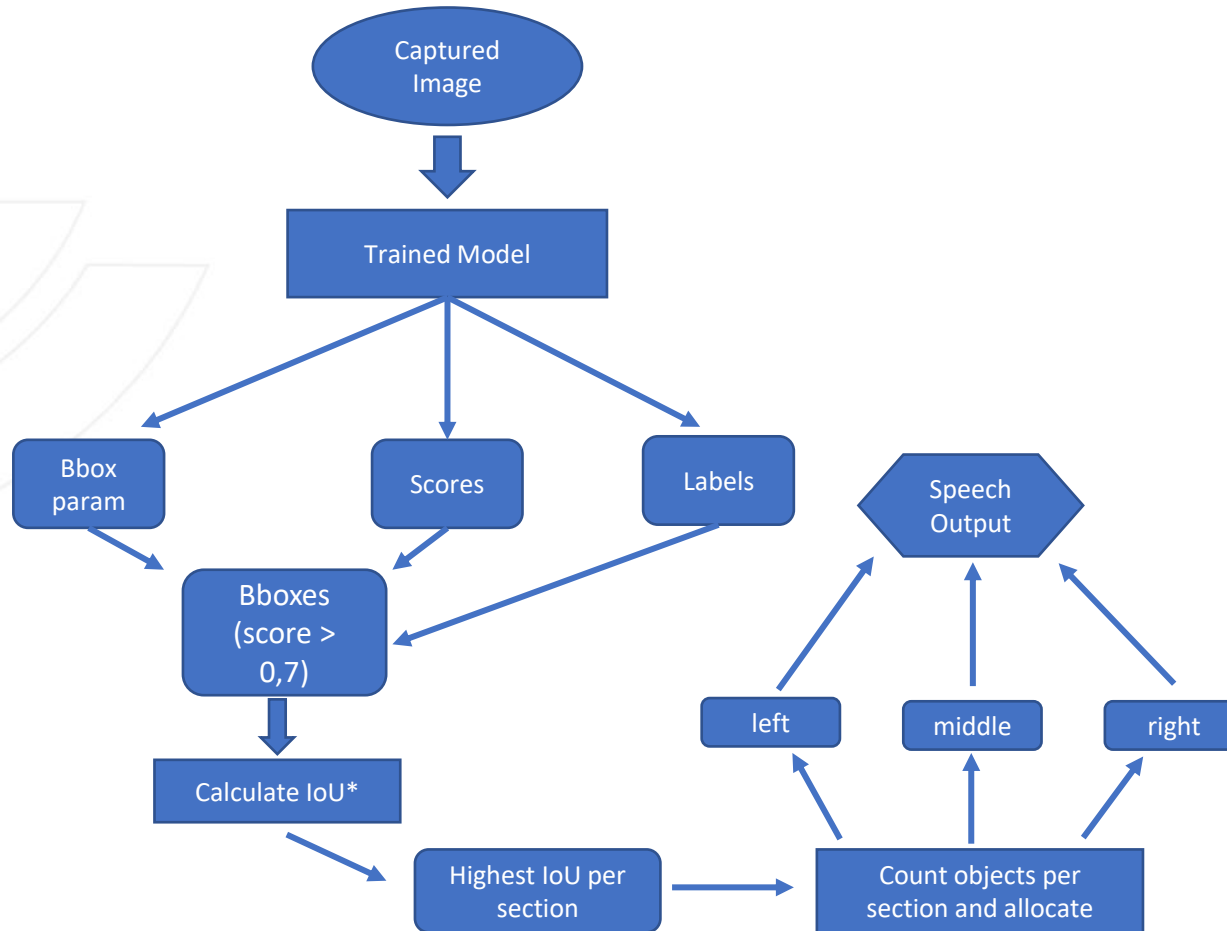
= Function



= Output



= Endresult

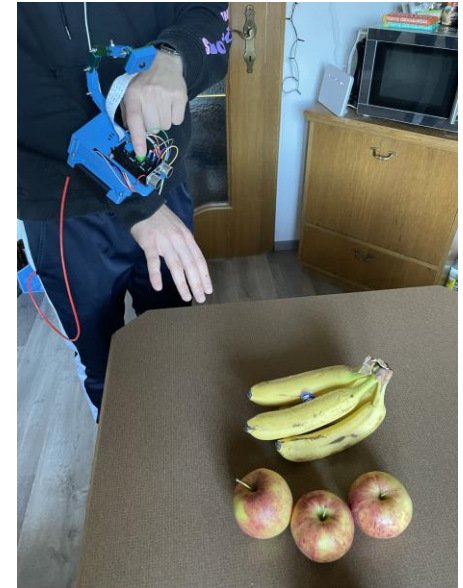
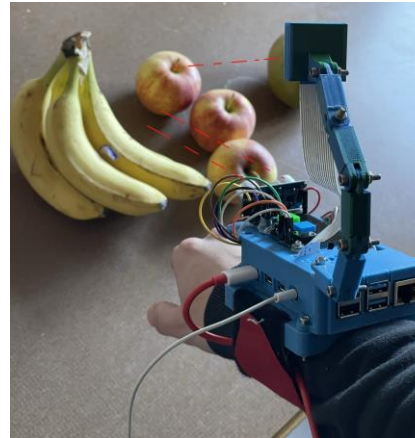


* Calculate Intersection over Union of Bounding Boxes and three different areas (left, middle, right)



Use-Case Scenario

- Mount the device on your wrist
- Turn on the power by plugging in the cable => programm will load automatically
- Press detection button to run image processing
- Results are given via headphones



Outlook

- Improve the Raspberry Pi housing => better cable management
- Find a faster and better running algorithm
- Gain more data to detect more different fruits (create our own dataset)
- Implementation of the object detection algorithm in the App to make it better affordable and more portable



Project References

- [1] V. Kulyukin and A. Kutiyawala, "Accessible shopping systems for blind and visually impaired individuals: Design requirements and the state of the art," *The Open Rehabilitation Journal*, vol. 3, no. 1, 2010.
- [2] J. Allamar, "A visual and interactive guide to the basics of neural networks," <https://towardsdatascience.com/the-concept-of-artificial-neurons-perceptrons-in-neural-networks-fab22249cbfc>, 2016, [Online; accessed 12.5.2022].
- [3] A. Naviani, "Neural network models in r," <https://www.datacamp.com/tutorial/neural-network-models-r>, 2019, [Online; accessed 17.5.2022].
- [4] D. Podareanu, "Best practice guide -deep learning," <https://www.researchgate.net/publication/332190148BestPracticeGuide-DeepLearning>, 2019, [Online; accessed 17.5.2022].
- [5] fast.ai reference, "Fully connected layer," <https://www.fast.ai/reference.com/tabular-data/fully-connected-layer>, 2019, [Online; accessed 17.5.2022].
- [6] S. Tu, M. Waqas, Z. Shah, Z. Yang, A. Koubaa et al., "Modpso-cnn: an evolutionary convolution neural network with application to visual recognition," *Soft Computing*, vol. 25, no. 3, pp. 2165–2176, 2021.
- [7] D. Pintado, V. Sanchez, E. Adarve, M. Mata, Z. Gogebakan, B. Cabuk, C. Chiu, J. Zhan, L. Gewali, and P. Oh, "Deep learning based shopping assistant for the visually impaired," in *2019 IEEE International Conference on Consumer Electronics (ICCE)*, 2019, pp. 1–6.
- [8] P. A. Zientara, S. Lee, G. H. Smith, R. Brenner, L. Itti, M. B. Rosson, J. M. Carroll, K. M. Irick, and V. Narayanan, "Third eye: A shopping assistant for the visually impaired," *Computer*, vol. 50, no. 2, pp. 16–24, 2017.
- [9] Ren, Shaoqing, et al. "Faster r-cnn: Towards real-time object detection with region proposal networks." *Advances in neural information processing systems* 28 (2015): 91-99.