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Judul:
Development of a Visual Aid Tool for Blind People Based on Faster R-CNN

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Iswahyudi, Khairul Anam, Bambang Sujanarko

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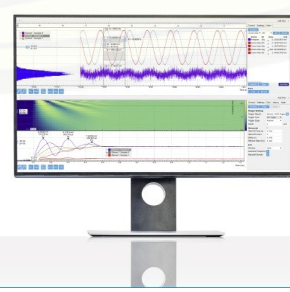

Preface: Climate Change and Sustainability Engineering in ASEAN 2019

We are delighted to present the Proceedings of the International Conference on Climate Change and Sustainability in ASEAN 2019 (CCSE-ASEAN 2019).

CCSE-ASEAN 2019 was held at the University of Jember, Indonesia, on 13 November 2019. This conference was hosted jointly by the Faculty of Engineering, University of Jember (Indonesia) and the School of Engineering, University of San Carlos (Philippines). The conference will be held annually on alternate cities of Jember (Indonesia) and Cebu (Philippines).

CCSE-ASEAN is an attempt to formulate the best response to climate change that poses increasingly significant threats to sustainable development in Southeast Asia. This conference aims at encouraging rich discussions and continuous collaborations among researchers, engineers, leaders in regional government and industries, and students on enhancing the role of the engineering field with its major innovations in ASEAN countries to mitigate climate change impacts.

CCSE-ASEAN 2019 received 171 submissions of abstracts and full papers. On the basis of a single-blind review process, in which two or three independent reviewers were assigned for each submission, 100 full-papers were accepted for oral presentation. The presenters at CCSE-ASEAN 2019 came from several countries including Indonesia, Philippines, Japan, China, and Iraq. The authors presented original scientific reports on varied topics but highly relevant to climate change and sustainability studies, including new models in disaster management, advances in biomaterials, novel analyses in renewable energy technologies, and uses of artificial intelligence and Internet of Things in farming. Based on further assessment on the overall quality of the presented papers, the CCSE-ASEAN Committee has selected 50 outstanding papers for submission to AIP Conference Proceedings.

Our sincere appreciation goes to all authors who have submitted their abstracts and papers to CCSE-ASEAN 2019 especially to the authors who presented their papers in the parallel session. Our deep gratitude goes to the reviewers for their dedicated work. We sincerely thank Prof. Evelyn Taboada (University of San Carlos, Philippines), Prof. Siti Rozaimah SA (Universiti Kebangsaan Malaysia, Malaysia), Prof. How- wei Chen (National Central University, Taiwan), Dr. Timotius Pasang (Auckland University of Technology, New Zealand), and Dr. Hermann van Radecke (Flensburg University of Applied Science, Germany) for having presented their insightful lectures in the plenary session. We would also thank all committee members of CCSE-ASEAN 2019 for their continuous hard work and cooperation, and we thank our sponsors for their support.

We do hope that all the participants of CCSE-ASEAN 2019 would gain meaningful inspiration and fruitful collaboration from the conference. We also wish them a joyful experience from their stay at Jember during CCSE-ASEAN 2019. We are looking forward to seeing you again in CCSE-ASEAN 2020.

Chair of CCSE-ASEAN 2019
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Development of a visual aid tool for blind people based on faster R-CNN

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Iswahyudi, Khairul Anam, and Bambang Sujanarko

Development of a Visual Aid Tool for Blind People Based on Faster R-CNN.

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Abstract. The technology used to help blind people has been developed using various technologies such as an ultrasonic sensor in the form of sonar system in the form of belts and watches. The sonar vision works based on the principle of reflecting a wave with a frequency of 20,000 Hz so that it can be used to determine the distance of an object in a range of up to 3 meters. However, the sonar system cannot identify the object. Computer Vision emerges as one of the most promising solutions. This article focused on developing blind visual aid using a Faster R-CNN identify an object. The Faster R-CNN is instilled on the raspberry pi equipped with a camera. The output is an audio signal about the object and its position refer to the users. The results of this study are able to recognize objects automatically well and accurately.

INTRODUCTION

So far, technology to help blind people has been developed, among the various technologies used, namely ultrasonic sensor technology[1]. Research on ultrasonic sensors as a visual aid has been developed, among others, is made a tool called sonar vision in the form of a belt and watch. This sonar vision technology works based on the principle of reflecting a wave with a frequency of 20,000 Hz so that it can be used to determine the distance of an object in a range of up to 3 meters. The weakness of this method is still experiencing obstacles in identifying an object. Computer Vision-based solutions emerged as one of the most promising options. Computer Vision is an interdisciplinary scientific field that discusses how computers can be made to obtain a high level of understanding of digital images or video. Previous research has also developed the use of computer vision[2]. In previous studies the method used was machine learning Haar-like feature to detects one object in one image. The weaknesses of these methods are less accurate for object detection, difficulty to detect many objects in the image, and can't know the position of the object sought. Based on the above problems we conducted this research, in this research we will use one of the deep learning methods, namely Faster R-CNN to detect objects by using the Raspberry Pi as a controller. The Faster R-CNN[3] method is a development of the CNN method. The Faster R-CNN was chosen because it has a faster ability to carry out a self-learning process for object recognition, object extraction, and classification. It is hoped that by using the Faster R-CNN method with Raspberry pi mini pc data processing, portable visual aids can be made to help visually impaired people to identify objects more quickly and accurately, thereby reducing the visibility of the blind to the people around them.

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SYSTEM OVERVIEW

Raspberry Pi 3

The Raspberry Pi 3 Model B + is a mini-computer that can be used for computer devices or other interesting projects. This Raspberry Pi Model B + uses a chipset that is Broadcom BCM2873B0 Cortex A53 64-bit 1.4GHz speed. This chipset has better temperature management so that it can run at full speed longer before experiencing heat throttling. This device uses a dual-band wireless connection that supports 802.11ac which is faster than the previous generation and also equipped with Bluetooth. Another connectivity is a USB 2.0 port that also supports 1 gigabit LAN using an adapter. Other connectors such as GPIO also remain available to connect to other devices.

FIGURE 1. Raspberry Pi B+

Faster R-CNN

Convolutional Neural Network (CNN)[4] is a method of deep learning (DL) that can be used to detect and recognize an object on a digital image.In Deep Learning, Convolutional Neural Network (CNN, or ConvNet) is a deep neural network class, which is most commonly applied to analyze visual images Example of the famous model CNN like VGG-16 [5], ResNet 50, DeepNet, AlexNet by ImageNet.

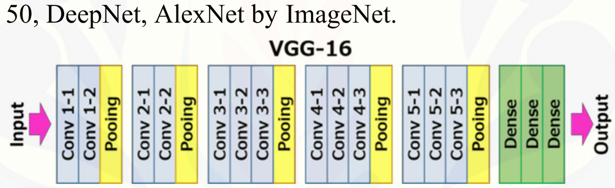

FIGURE 2 VGG-16 architecture[5]

CNN method also continues to be developed until now, R-CNN [6] published in 2014, Fast R-CNN [7] published in 2015, Finally The Faster R-CNN[3] in 2017. The Faster R-CNN itself is actually composed of two modules. The first module is a module that is in a fully convolutional network that proposes regions, and the second module is a Fast R-CNN detector.

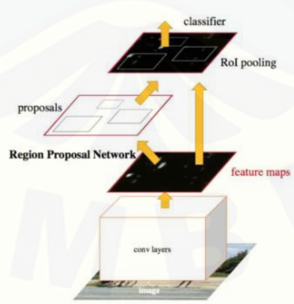

FIGURE 3 Model Faster R-CNN[3]

Algorithm Faster R-CNN to object detection in images:

1. First Take the input image and give it to ConvNet which returns the map feature for the image
2. Second Apply the Regional Proposal Network (RPN) on this feature map to get object proposals
3. Third ROI pooling layer to bring down all the proposals to the same size
4. Lastly, submit this proposal to a fully connected layer to classify bound prediction boxes for images

RESEARCH METHODS

In this research, the method used is Faster R-CNN. Input image sensor using a mini camera that functions to capture images, sound sensor to receive user commands using a microphone with method speech recognition[8], audio speaker output to guide the user, the power bank functions as a power supply, and Raspberry pi 3 as the main controller to process image data and voice commands. The figure below is a block diagram of the Design Development of Visual Aids for Blind People Based on Faster R-CNN.

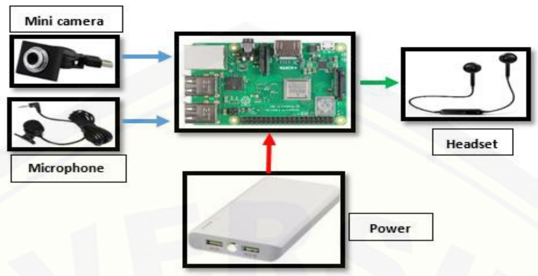

FIGURE 4. Block Overall System Diagram

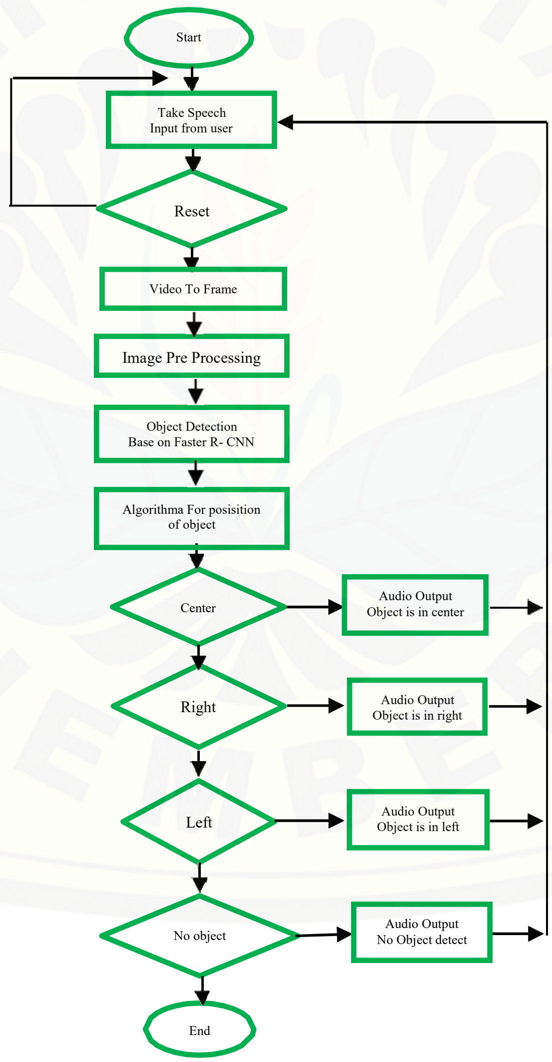

FIGURE 5. Flow graph of object Detection

Software Development Faster R-CNN

First download and Extract annotation for custom classes from Google's Open Images Dataset v4 (Bounding Boxes), download the tree file in the picture. The Open Images Dataset V4 dataset is containing 600 classes too large for me. I extracted 1,000 images for eighteen classes including tables, chairs, door, plates, spoons, person, glasses, bags, book, phones, window, sunglasses, laptops, boot, television, helmet, fork, and bottle. I use 80% images for training and 20% images for testing.

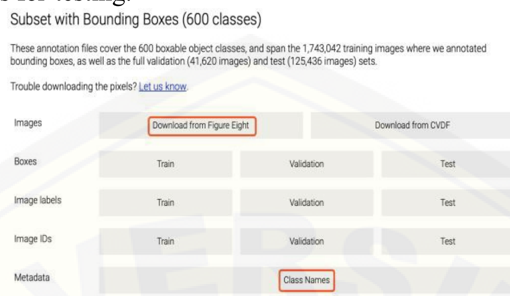

FIGURE 6. Website Open Images dataseet V.4

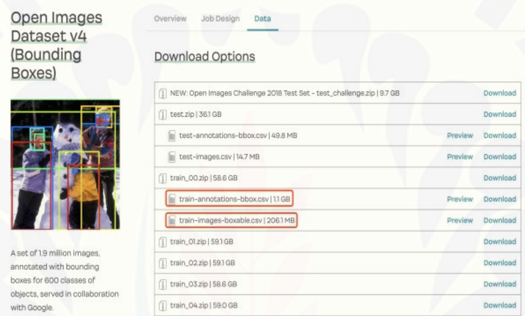

FIGURE 7. Website Figure Eight website

Second Prepare Faster R-CNN code

1. Rebuild the structure of VGG-16 and load a pre-trained model
2. Prepare training data and training labels (get_anchor_gt)
3. Calculate RPN for each image (calc_rpn)
4. Calculate the region of interest from RPN (rpn_to_roi)
5. RoIPooling layer and Classifier layer (RoiPoolingConv, classifier_layer)

Make training the dataset that has been created
The loss function is defined as:

$$L(\{P_i\},\{t_i\}) = \frac{1}{N_{cls}} \sum_i L_{cls}\,(P_i, P_i^*) + \ \lambda \frac{1}{N_{reg}} \qquad (1)$$

i = value index of an anchor in a mini-batch
p*i* = predicted the probability of anchor i being an object.
p*i**** = ground-truth label, 0 if the anchor is negative and 1 if positive
t*i* = vector representing the four parameterized coordinates of the predicted bounding box associated with a positive anchor
t*i**** = vector representing the four parameterized coordinates of the ground-truth box associated with a positive anchor

The classification loss (*first term*) is log loss over two classes. For the regression loss (*second term*), the smooth L1 loss is used

$$t_x = \frac{x - x_a}{w_a} \qquad t_y = \frac{y - y_a}{h_a} \tag{2}$$

$$t_w = log\left(\frac{w}{w_a}\right) \quad t_h = log\left(\frac{h}{h_a}\right) \tag{3}$$

$$t_x^* = \frac{x^* - x_a}{w_a} \qquad t_y^* = \frac{y^* - y_a}{h_a} \tag{4}$$

$$t_w^* = log\left(\frac{w^*}{w_a}\right) \quad t_h^* = log\left(\frac{h^*}{h_a}\right) \tag{5}$$

Variables x, xa, and x* are for the predicted box, anchor box, and ground-truth box respectively (similarly for y, w, h). For preliminary research we use a webcam to capture images. I used Laptop core I5 1.8GHz, Ram 6GB, and GPU NVIDIA GFORCE 710M for the training, I choose 115 epoch number with epoch length 250, each epoch requires an average time of 4200s or 17s / step. Training results in an accuracy rate above 80%.

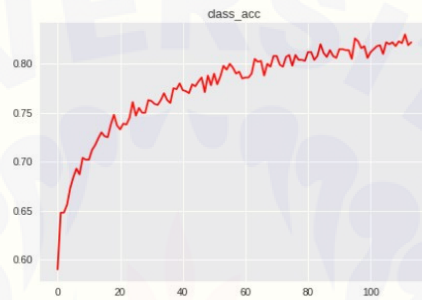

FIGURE 8. Result train

Speech Recognition

In this study using the Google Speech API to identify sounds. The Google API was chosen because Google has improved speech recognition by using new technology in many applications.

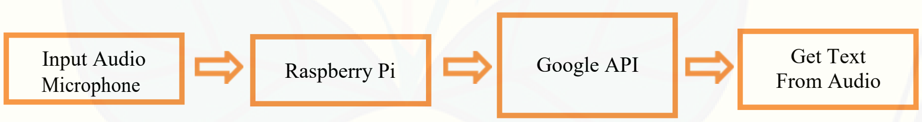

FIGURE 9. Google API Speech Recognition process

EXPERIMENT AND RESULT ANALYSIS

After the training and test dataset process, the next stage is the trial phase of the model that we have made using the mini camera module connected to the Raspberry Pi. The mini camera module is used to take high-resolution video, as well as still images. The output from the camera is fed to Raspberry Pi for further processing. To do image recognition, we will first need a dataset and the labels of what is contained in the image. The system is focused on object detection and object positioning. This system is made like glasses. Raspberry Pi accepts video that is connected to the Pi camera, and the video is converted into a frame by the processor. Voice commands are spoken by the user when he searches for or needs an object. Speech input is recognized by the Raspberry Pi, then the system guides the user to find the object needed through the audio speaker output.

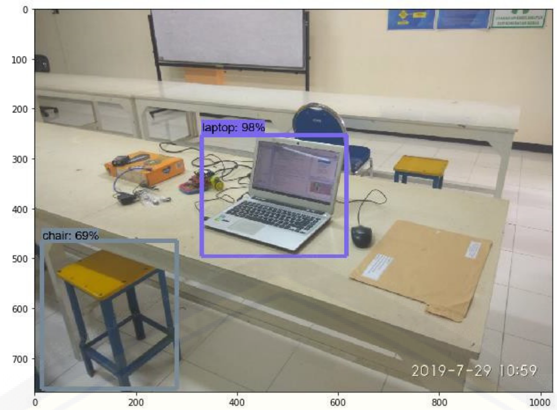

FIGURE 10. Result Detection Object in image

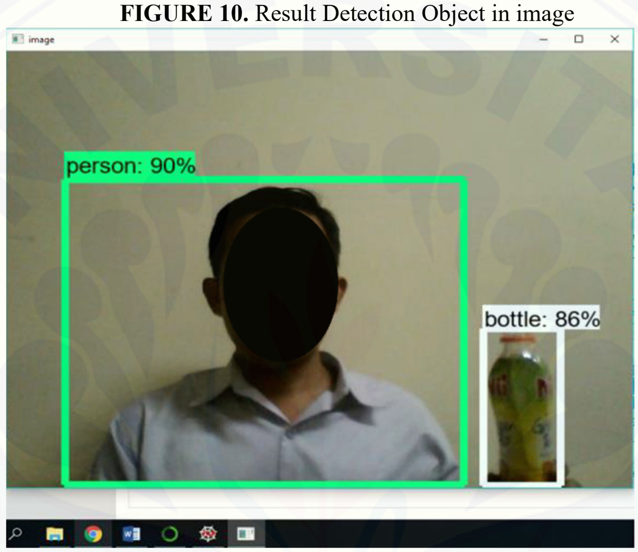

FIGURE 11. Result Detection object in video

CONCLUSION

The purpose of this study was to develop visual aids for blind people using cameras as a visual substitute using the Conventional Neural Network method with a Raspberry Pi controller. The existence of this tool is expected to help the blind to identify obstacles and the position of the object being sought, thereby reducing the dependence of the blind to the people around them.

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