Precise Weed and Maize Classification through Convolutional Neuronal Networks

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Presentation Outline

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Introduction

Introduction

- Maize(*Zea mays*) is one of the most important crops of the world.
- Weed can affect maize crop yield up to 5000 Kg/Ha.[1]
- Robotics has had significant contributions to Precision Agriculture.
- Artificial Intelligence reached near-to-human precision.

Purpose of the present study

- Obtain samples to conform a dataset
- Segment samples
- Test accuracy in different network architectures of Convolutional Neural Networks for Maize and Weed Clasification
- Benchmark the best network architecture to analyze processing time
- Optimize the network processing speed

[1] R. SUÁREZ and J. P. Y. J. VALLADARES, "Distintos sistemas de escarda en maíz forrajero," *Producciones agroganaderas: Gestión eficiente y conservación del Medio Natural. Actas de la XLV RC de la SEEP. Gijón*, 2005.

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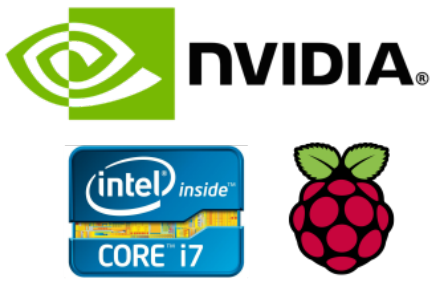
Used Hardware and Software

Hardware

1. Raspberry Pi 3.
2. Pi camera V2.1.
3. Nvidia graphic Card GTX950M.

Software

1. OpenCV Library
2. Caffe framework
3. Ubuntu 16.04
4. PIXEL Distribution derived from Debian.



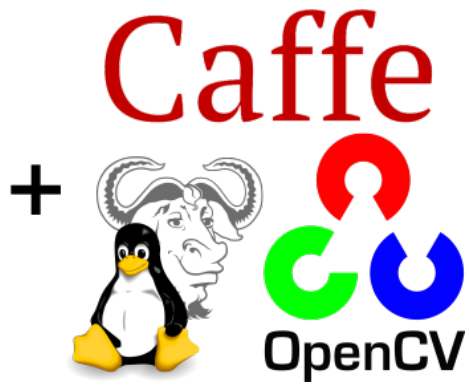


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Image Processing

- Acquire an RGB image through RPi Camera v2.1(Centered to the plant)
- Normalize Green Channel and then $S = 2 * G - R - B$ [2]
- OTSU Thresholding
- Detect contours and crop image to the contour
- Mask image

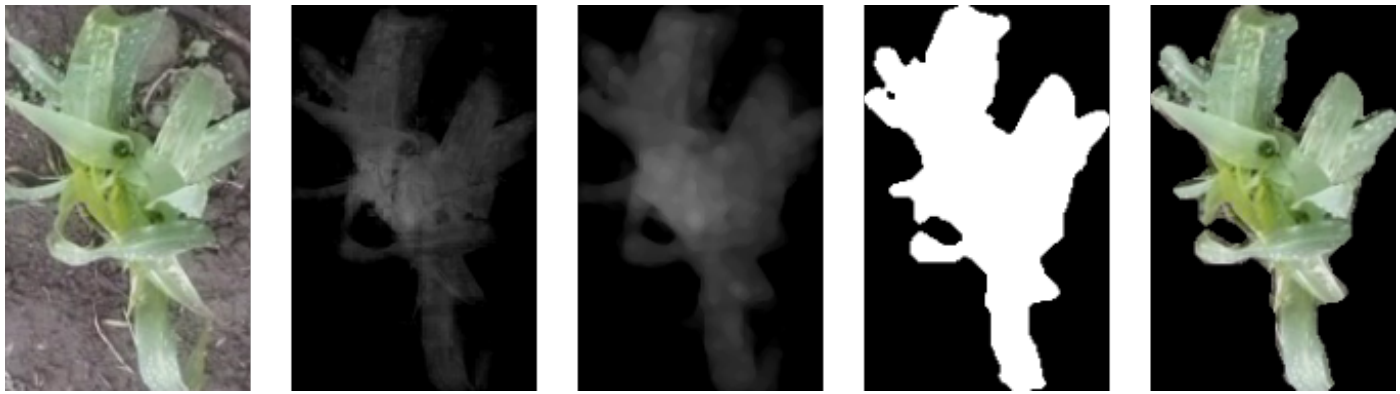

Figure: Steps of image processing(Cropped image)

[2] P. Wang, Z. Meng, C. Luo, and H. Mei, "Path recognition for agricultural robot vision navigation under weed environment," in *7th International Conference on Computer and Computing Technologies in Agriculture (CCTA)*, no. Part I. Springer,

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Dataset

- Samples obtained in Pillaro-Tungurahua-Ecuador
- Images obtained in its initial stage(3-7 leaves) .
- Rotated images every 30° to improve plant detection [3]
- 1/5 of the total images chosen randomly to validate training

Table: Dataset distribution of each class

Images	Maize	Weed
Original	2835	880
Rotated	34222	10762
Training	25695	8560
Validation	8325	2000

[3] S. Sladojevic, M. Arsenovic, A. Anderla, D. Culibrk, and D. Stefanovic, "Deep neural networks based recognition of plant diseases by leaf image classification," *Computational intelligence and neuroscience*, vol. 2016, 2016.

Samples

- Maize Plants *(Zea maiz)*




- Weed Plants *(Urtica Urens, Lysimachia vulgaris , Chenopodium álbum , Malva Capestri)* [4]




[4] COBA ROBALINO, José María. *Monografía General del Cantón Píllaro.*

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Convolutional Neural Networks(CNN)

- Highly accurate method for image classification
- A class of deep, feed-forward artificial neural networks
- Tested on classification of plants, [5] [6]
- Multiple architectures and applications

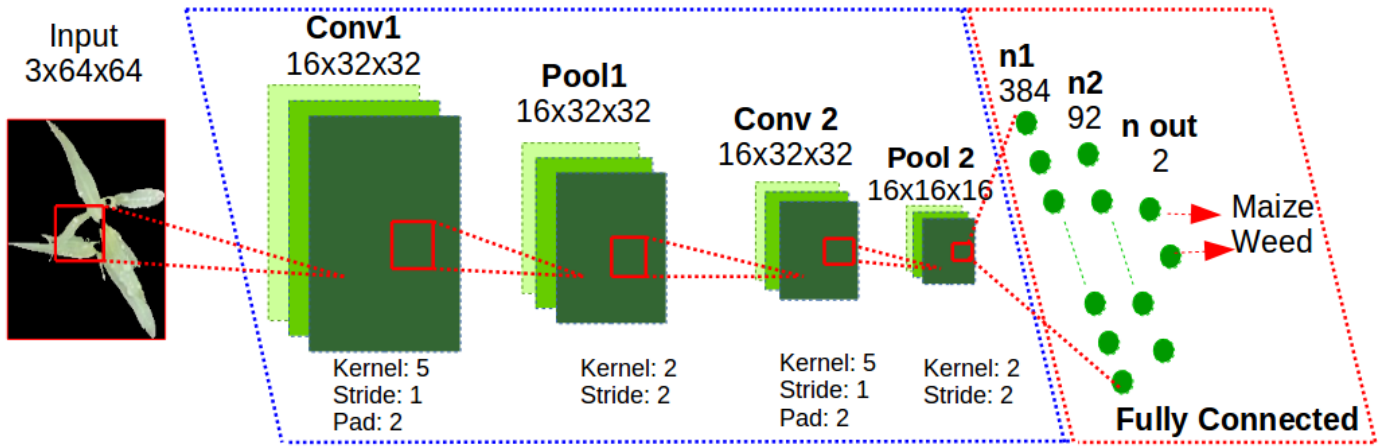

Figure: Normal architecture in a Convolutional Neural Network

[5] B. Cheng and E. T. Matson, "A feature-based machine learning agent for automatic rice and weed discrimination."

[6] C. Potena, D. Nardi, and A. Pretto, "Fast and accurate crop and weed identification with summarized train sets for precision agriculture"

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Tested Architectures

- LeNET and AlexNet(Caffe Zoo Model)
- cNET and sNET [7]
- 3000 iterations in each training

Table: Comparison of the 4 types of CNN in training the dataset

Parameters	**LeNet**	**AlexNet**	**cNET**	**sNET**
Input size of images	32x32	64x64	64x64	64x64
Layers numbers	9	11	8	4
Number of parameters	652500	20166688	6421568	135872
Accuracy(%)	86.48	93.86	96.4	80.4
Loss(%)	32.80	15.32	13.72	15.32

[7] C. Potena, D. Nardi, and A. Pretto, "Fast and accurate crop and weed identification with summarized train sets for precision agriculture"

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cNET Performance

1. cNET can be improved by decreasing the number of filters
2. Images can be batched and also Caffe can be multithreaded
3. Both nets were trained with 9000 iterations

Table: Comparison between cNET of 16 and 64 filters

Parameters	**cNET 16 filters**	**cNET 64 filters**
Number of parameters	1651376	6421568
Accuracy(%)	97.26	96.40
Loss(%)	8.39	13.72

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Estimated performance of cNET 16 filters

- A test dataset with 202 images of each class was used
- 18 plants can be found in a single image approximately to be classified

Table: Test of complete image classification in FPS

Parameter	**GPU**	**CPU**	**Raspberry Pi**
Method	**One Core**	**Multithreading**	**Multithreading**
Time(s)	0.0171	0.196	2.714
FPS	58.47	5.08	0.36

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Conclusion

- cNET showed the best results in classification of maize and weed
- The reduction of the number of filters decreased the processing time and increased the network accuracy
- GPU showed the best results, but with Multithreading and Batching CPU and Raspberry Pi can improve its processing time
- Due to the limitations of the Raspberry Pi, it can't be used to classify in real time, but a Neural Module(such as Intel Movidius) can improve that result

Thanks!