AI image processing using image data from RedEdge camera

Kornrawat Aneknit[1], Saharat Suwansiri[2], Chonnakarn Promyoo[3]
Faculty of Science and Technology Rajamangala University of Technology Thanyaburi
Thanyaburi Pathumthani Thailand 12110

Co-operative Education at Hokkaido Information University 59-2 Nishinopporo, Ebetsu, Hokkaido 069-0832, Japan

Abstract

Multispectral camera is powerful tool to investigate the agricultural crop and forest growths. However, the image data obtained by the camera is not fully used in the field of Agriculture and Forestry, because the spectrum of reflection lights from different crops and forest is not understood in detail. We investigate the reflected lights in the growth process of the crops with a RedEdge professional multispectral camera. Python supports a lot of algorithms related to Machine Learning, Python Imaging Library (PIL), NumPy library and Chainer deep learning framework for neural networks. The program consists of the RedEdge multispectral camera operation, the data acquisition, the image data processing such as the vegetation index including affine transformation, supervised learning and unsupervised learning AI programming to inspect input image data and output image shows detected crop or vegetation from input image data.

Keywords: Artificial Intelligence, Remote Sensing, Vegetable classification, Fruits classification, RedEdge;

1. Introduction

Nowadays the use of Remote Sensing is widely used in agriculture and it is the foundation in this decade for example Analysis, Classification and so on but even today there are new technologies developed and it can enhance the performance in analysis and some technology can be apply, in the present Artificial Intelligence it has played an important role in many aspects included agriculture. The vegetation classification is an important aspect of the remote sensing application. Due to the diversity of vegetation for example cells structure, chlorophyll, colors etc. to make this kind of application it is a challenging work. According to Tempfli's paper [1], the reflectance characteristics of vegetation depend on the properties of the plants, the reflectance in the NIR range is the highest but depends on plant development and cell structure. However, to achieve the good result we need a multi-spectral sensor because the sensor can provide an information in RGB including NIR range, in our work we use RedEdge Camera from MicaSense company [2], the camera is a multi-spectral camera that has bands: blue, green, red, NIR and red edge. There are many researchers or experts studied in vegetation classification. Sa et al [3] studied to classify fruit in real time using DCNN framework they use RGB and NIR data, the accuracy of fruit detection is up to 0.83. Our work focuses on using data from RedEdge Camera and training in Supervised model to classify vegetables and fruits images and comparing with Unsupervised model. To processing these, we use Python3 and the post-processing of vegetable and fruits images data from multi-spectral camera were performed.

2. Theory

2.1 Image Processing[4]

Image processing is method to perform some operations on an image or calculate with a computer to get the information we need both qualitatively and quantitatively. There is an important method for example methods that make the image sharper, removing noise from image, the division of objects we are interested from the image. Then we analyze quantitative data, such as size, shape and direction of moving objects in the image to create a system, for example Road traffic surveillance and monitoring system by counting the number of vehicles on the road in the photos with CCTV at each time. These

systems require a lot of image processing. The process needs to be repeated. If human analyzes, it takes a lot of time.

2.2 Artificial Intelligence[5]

Artificial intelligence is about making a computer that resembles a human or imitating a human behavior. It is a software that is used with computers. Especially the ability to think for themselves or have intelligence. Humans are created intelligence for computers. So, called artificial intelligence.

2.3 Artificial Neural Network[6]

An Artificial Neural Network (ANN) is an information processing paradigm inspired by the biological neural networks. Its relatively crude electronic models based on the neural structure of the brain. This process of storing information as patterns, utilizing those patterns, and then solving problems encompasses a new field in computing. This field involves the creation of massively parallel networks and the training of those networks to solve specific problems and utilizes words, ANN is very different from the traditional computing.

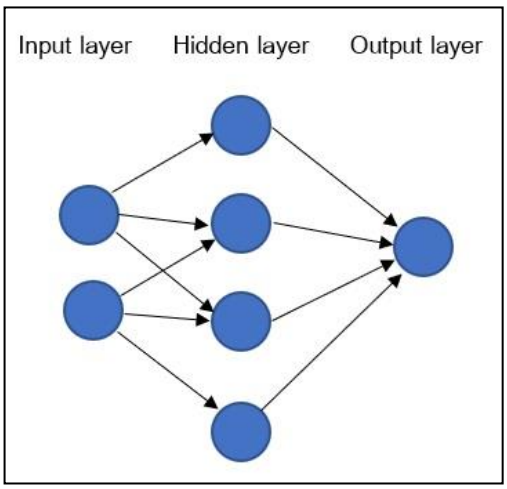

Figure 1. a simple neural network

Artificial Neural Network is mathematical model or computational model, an information processing paradigm. It configures for solving artificial intelligence problems without creating a model of real biological system. ANN is used for speech recognition, image analysis, adaptive control etc. All are done through a learning process.

2.3.1 Supervised Training both the inputs and the outputs are provided. The network then processes the inputs and compares its resulting outputs against the desired outputs. The set of data which enables the training is called the "training set". During the training of a network the same set of data is processed many times as the connection weights are ever refined.

2.3.2 Unsupervised, or Adaptive Training the network is provided with inputs but not with desired outputs. The system itself must then decide what features it will use to group the input data. This is often referred to as self-organization or adaption.

3. Methodology

3.1 Materials and Method

3.1.1 RedEdge Camera is a multi-spectral camera developed in a last couple year from MicaSense company. The camera had a multi-spectral sensor, the sensor is sensitive in a following wavelength: Blue (475 nm), Green (560 nm), Red (668 nm), NIR (840 nm) and Red edge (717 nm).

3.1.2 Image Capturing with RedEdge Camera. First step is to prepare our training data, in this work we use 5 difference kinds of vegetables and fruits including 3 vegetables and 2 fruits as show in Figure 2. 1.) Tomato 2.) Carrot 3.) Broccoli 4.) Bananas 5.) Grapes, and each type had 5 split images for each wavelength as following: blue, green, red, NIR and red edge.

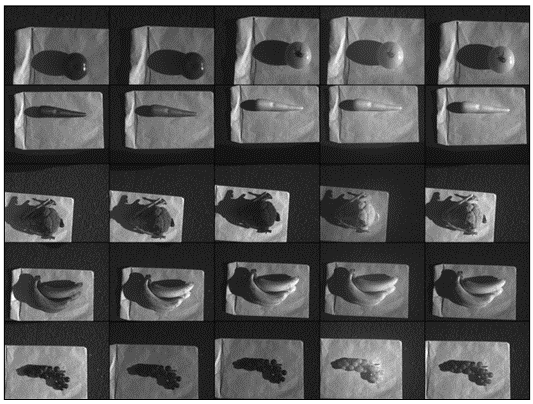

Figure 2. Images of vegetables and fruits captured by RedEdge camera

Even we had all the data we wanted but the problems we encounter is, if we look closely in Figure 2 the images captured by RedEdge camera is not aligned perfectly if we combine them. To illustrate in Figure 3, it shows before and after combining RGB images

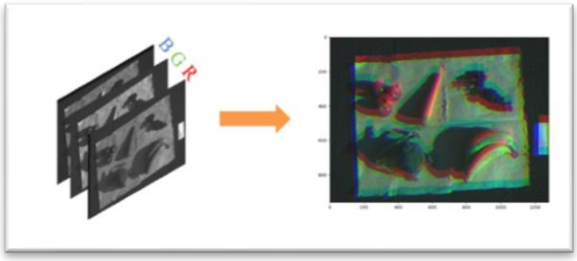

Figure 3. Before and After combining RGB images

The data file for classification is an important aspects of AI classification. To resolve this problem, we need a pre-processing method to align the images captured by RedEdge camera. In this work we do the alignment manually by using OpenCV framework in Python 3, at first step we marked the dot before we perform capture an image and then we input the position of the dot for each images into our program, in our work we used green image as a base image and other image such as blue, red, NIR and red edge to aligning with the green image and the final result of aligning RGB image shows in Figure 4.

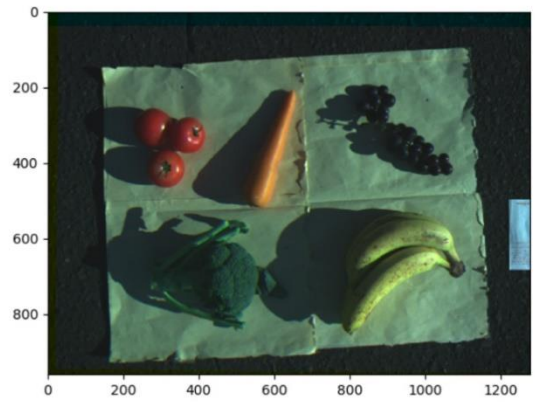

Figure 4. Perfectly aligned of RGB image

3.1.4 Making data file for classification. This step is about making data file for inputs in our classification model, in the section3.1.2 we have shown that the images captured by RedEdge camera if we combine them we can see that the images is not aligned. So, we have to align it manually. After we aligned each images we can now use the aligned images to be inputs in our classification model. Now we have 5 aligned images first we have to select an area of interest which is the area of a vegetable or fruit after selected an area of interest, we write the pixel values of each images of a vegetable or fruit in our selected area to a text file and we added some value in each rows to be a determinant of each type, because we will use this data file in supervised classification, for example in data file we have 5 values of bananas of each images 73 90 55 93 75 and then we added a determinant 1 0 0 0 0 for bananas and if we add a carrot data we should add a determinant like 0 0 1 0 0 for carrot to illustrate (see figure 5).

```
1   73 90 55 93 75 1 0 0 0 0
2   76 94 57 93 77 1 0 0 0 0
3   77 94 58 94 79 1 0 0 0 0
4   79 93 58 96 79 1 0 0 0 0
5   78 92 60 95 83 1 0 0 0 0
6   79 97 60 96 81 1 0 0 0 0
7   82 97 61 97 81 1 0 0 0 0
8   82 98 58 97 80 1 0 0 0 0
9   85 100 59 100 83 1 0 0 0 0
10  82 99 61 102 85 1 0 0 0 0
11  83 105 61 100 83 1 0 0 0 0
12  84 99 63 100 87 1 0 0 0 0
13  76 89 58 95 82 1 0 0 0 0
14  77 93 60 97 81 1 0 0 0 0
15  79 92 61 99 82 1 0 0 0 0
16  81 95 60 97 81 1 0 0 0 0
17  81 97 60 96 84 1 0 0 0 0
18  83 99 61 100 82 1 0 0 0 0
```

Figure 5. Pixel values in data file

3.1.5 Supervised Model. In this study we use Chainer framework to make a Supervised classification to classify our data file. This model type needs a rule to teach the model that is why in our data file we have a determinant which will tell the model to know that pixels is some vegetable or some fruit. The determinant value or output value should have same amount of type of training image, in Figure 6 shown a diagram of supervised model

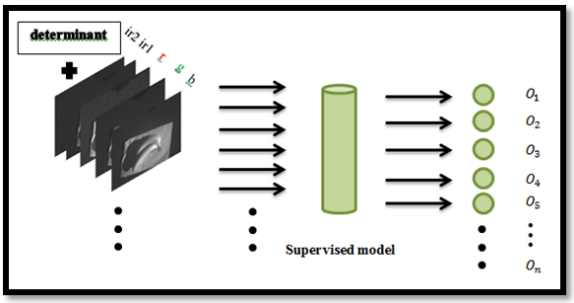

Figure 6. Diagram of supervised model

In Figure 6. Show the procedure of the training in supervised model we input 5 data from aligned images and a determinant value. The inputs must be normalizing except determinant value before the calculation.

3.1.6 Unsupervised Model. We also perform a classification with the unsupervised model to demonstrate the result in difference method. This model can automatically classify the inputs data without determinant value. So, we can only input the data and the model will automatically classify. Same as the supervised model we need to normalize the inputs first by using the same

equation, the diagram of unsupervised model shown in Figure 7.

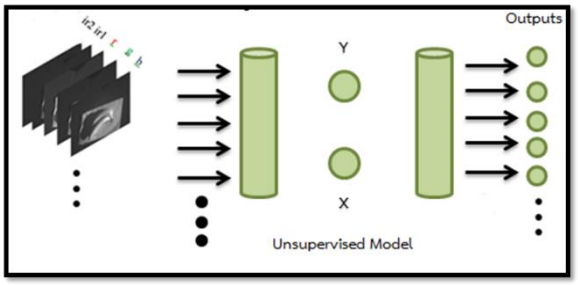

Figure 7. Diagram of unsupervised model

In Figure 7. We take only inputs of each images and then the model can distinguish the inputs, the 2 hidden nodes are the output of the classification they represent the X Axis and Y Axis and we plot the graph with that result. Note that we just to demonstrate how the model work with the data file and the result is shown in section4.

4. Result

In this section, we will discuss the classification result of the model presented in the previous section. First, we will show the result of the supervised model compared to each hidden node and show the error data of each amount of hidden node. In Figure 8 it shows the hidden nodes is 500 with 2 hidden layers and the iteration is 1,000 times.

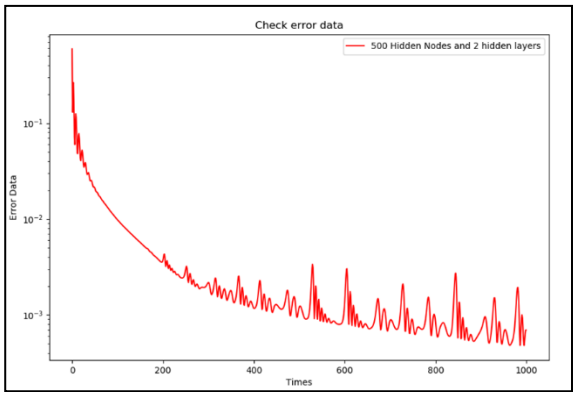

Figure 8. Graph of error data

4.1.1 Supervised classification model

Next, we will show the result of supervised classification model in Figure 8, which shows the result of classification by using supervised model we use 1 test image which have all the vegetables and fruits in 1 image and then we used supervised to classify the test image and mark the dot that corresponding in the data file, the output of supervised model sometimes it's not perfectly. So, we have to calculate the probability of the outputs. In this work, we use 500 hidden nodes with 2 hidden layers and iteration of 1,000. After calculated the probability we compare the probability value with the maximum value in that probability for example if the maximum of probability is at index 0(tomato) and the probability of O_0 > 0.9 we mark the red dot. And the final result of using supervised model as shown in Figure 9.

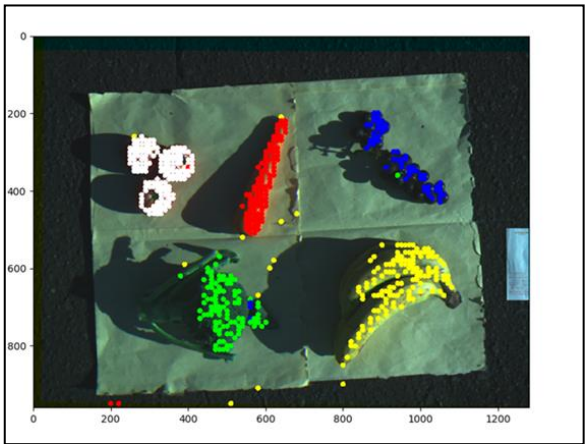

Figure 9. Classification result of supervised model

4.2 Unsupervised classification model

This result we will show you is to demonstrate the classification result of unsupervised model. we use the same test image input into unsupervised model and the result is shown in Figure 10.

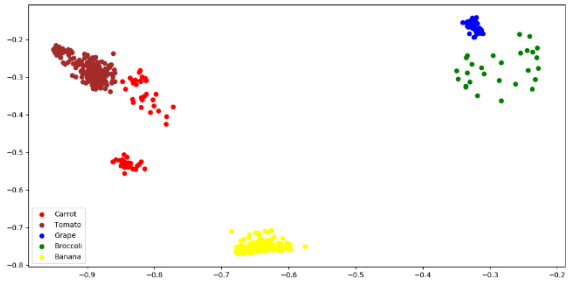

Figure 10. Unsupervised classification result

5. Acknowledgement

This research "AI image processing using image data from RedEdge camera" accomplished with the advice of Professor Shigeto Watanabe. We would like to thank to Professor Shigeto Watanabe for his assistance and his cooperation in this project. He taught us about image processing, AI programming, science and some useful general remote sensing. Sometimes he took us to other place for new experiences in Japan.

We would like to thanks to Dr. Keeratiburt Kanchanasatian and Dr. Pongpon Nilaphruek about give us an opportunity to internship at HIU. They contact to HIU about our internship for us and they give us some useful advice about international cooperative education and We also thanks to Mr. Keita Odajima for guidance, taking care of us, useful information about daily life in Japan.

We take this opportunity to express our sincere thanks. We will bring knowledge to use in our work in the best possible way and We will improve ourselves even further.

References

[1] K. Tempfli, N. Kerle, Gerrit C. Huurneman, Lucas L, F. Janssen, “Principles of Remote Sensing”, Enschede, Netherlands, pages 81 – 82, 2009.

[2] MicaSense, lnc., “RedEdge User Manual”, Seattle, WA, 2015, Available online: https://support.micasense.com

[3] Sa l, Ge Z, Dayoub F, Upcroft B, Perez T, McCool C, “DeepFruits: A Fruit Detection System Using Deep Neural Networks”,Brisbane, Australia, 2016.

[4] mindphp.com, “What is Image Processing?” [Online]. Available: http://mindphp.com/. [Accessed October 2018].

[5] mindphp.com, “What is AI?” [Online]. Available: http://mindphp.com/. [Accessed October 2018].

[6] Sonali. B. Maind, Priyanka Wankar, “Research Paper on Basic of Artificial Neural Network”, Wardha, India, pages 96 – 100, 2014.

Mr. Kornrawat Aneknit
Department of Information Technology
Rajamangala University of Technology Thanyaburi
Address 171/5 Sakaengam19 Sakaengam Rd. Bangkhuntian Bangkok 10150
Telephone No. 0888020609
E-mail nutgangza@hotmail.com

Mr. Saharat Suwansiri
Department of Computer Science
Rajamangala University of Technology Thanyaburi
Address 36/552 M.3 Prueksa 12/1 T.khlongsam A.khlong luang Pathum Thani 12120
Telephone No. 0984272274
E-mail james_mafiaz@hotmail.com

Mr. Chonnakarn Promyoo
Department of Computer Science
Rajamangala University of Technology Thanyaburi
Address 57/176 Nimitmai9 Nimitmai Rd. Sai Kong Din Klongsamwa Bangkok 10510
Telephone No. 0971125115
E-mail aumstandalone@hotmail.com