



Classification of Banana Ripening Stages with AlexNet Architecture

Selami Kesler¹, Abdil Karakan^{2*}, Yüksel Oğuz³

¹ Pamukkale University, Faculty of Engineering, Department of Electrical and Electronic Engineering, Denizli, Turkey, (ORCID: 0000-0002-7027-1426), skesler@pau.edu.tr

^{2*} Afyon Kocatepe University, Dazkırı Vocational Scholl, Department of Electricity, Afyonkarahisar, Turkey, (ORCID: 0000-0003-1651-7568), akarakan@aku.edu.tr

³ Afyon Kocatepe University, Faculty of Technology, Department of Electrical and Electronic Engineering, Afyonkarahisar, Turkey, (ORCID: 0000-0002-5233-151X), yukseloguz@aku.edu.tr

(First received 18 February 2023 and in final form 25 August 2023)

(DOI: 10.31590/ejosat.1252946)

ATIF/REFERENCE: Kesler, S., Karakan, A., & Oğuz, Y. (2023). Classification of Banana Ripening Stages with AlexNet Architecture. *European Journal of Science and Technology*, (51), 135-141.

Abstract

Banana is one of the most delicious fruits. Banana has high nutritional value. At the same time, bananas are high in nutritional values. Bananas contain a large amount of potassium. It is collected from the banana branch as green. Banana ripens very quickly after being picked. Banana ripens as it turns from green to yellow. Yellow bananas are ripe and sweetened at the same time. With the study, seven different ripening stages of banana fruit were determined by artificial intelligence. For this, pictures were taken of the banana fruit until it ripened after it was plucked from the branch. 700 photos were taken from five different ripening stages of the banana fruit. A data set was created with these photographs. With this data set, classification was carried out with deep learning. AlexNet architecture is used in deep learning. With the AlexNet architecture, an accuracy of 96.63% has been achieved. With deep learning, the ripening stages of the banana plant were determined. Thus, it will be possible to automate the ripening of the banana plant. In this way, it will be possible to increase productivity in the ripening stages of the banana.

Keywords: Artificial Intelligence, Deep Learning, AlexNet, Classification, Banana Ripening Stages.

AlexNet Mimarisi ile Muz Olgunlaşma Evrelerinin Sınıflandırılması

Öz

Muz lezzetli meyvelerin en başında yer almaktadır. Muzun besleyici değeri yüksektir. Aynı zamanda muz besin değerleri bakımından yüksektir. Muzun içeriğinde yoğun miktarda potasyum bulunmaktadır. Muz dalından yeşil olarak toplanmaktadır. Muz koparıldıktan sonra çok hızlı olgunlaşmaktadır. Muz yeşilden sarıya döndükçe olgunlaşmaktadır. Sarı muz olgunlaşmış aynı zamanda tatlanmıştır. Yapılan çalışma ile muz meyvesinin yedi farklı olgunlaşma evresinin yapay zekâ ile tespiti sağlanmıştır. Bunun için muz meyvesinin dalından koparıldıktan sonra olgunlaşmaya kadar resimleri çekilmiştir. Muz meyvesinin yedi farklı olgunlaşma evresinden 700 fotoğraf çekilmiştir. Bu fotoğraflarla bir veri seti oluşturulmuştur. Bu veri seti ile derin öğrenme ile sınıflandırması gerçekleştirilmiştir. Derin öğrenmede AlexNet mimarisi kullanılmıştır. AlexNet mimarisi ile %96,63 oranında bir doğruluk elde edilmiştir. Derin öğrenme ile muz bitkinin olgunlaşma evrelerinin tespiti sağlanmıştır. Böylelikle muz bitkisinin olgunlaşmasında otomasyona geçilebilecektir. Bu sayede muzun olgunlaşma aşamalarında verimlilik artışı sağlanabilmesi gerçekleşecektir.

Anahtar Kelimeler: Yapay Zekâ, Derin Öğrenme, AlexNet, Sınıflandırma, Muz Olgunlaşma Evreleri.

* Corresponding Author: akarakan@aku.edu.tr

1. Introduction

Banana grows naturally in tropical regions. The banana plant looks like a tree. Banana has green, pink and yellow colors. Bananas are picked mostly green. The green-picked banana is unripe. As the banana ripens, it turns from green to yellow. The yellow period banana is also sweetened. Banana is a fruit eaten by people of all ages. For this reason, it is widely grown commercially. Figure 1.1 shows the places where bananas are grown in the world. It also shows how much production has been made.

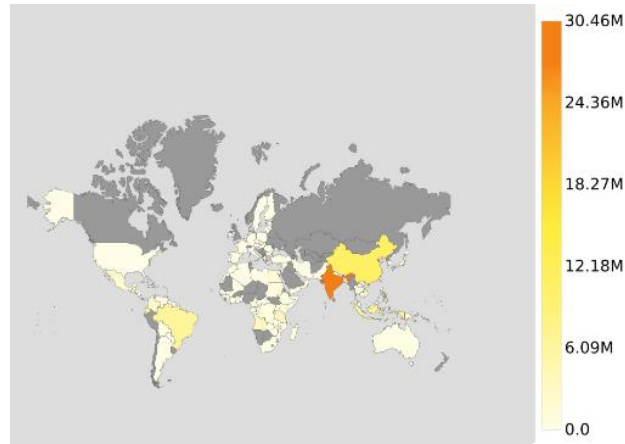


Figure 1.1 The amount of banana production and production areas in the world.

Banana is a perennial plant. The length of the banana plant rises up to 8-9 meters. For this reason, it is also called a tree. The leaves of the banana plant are large and long. It also has long fruits. Banana grows very easily in tropical environments. The average temperature must be 26 °C for the efficient growth of bananas. Figure 1.2 shows the banana plant and its fruit.



Figure 1.2 Banana plant and fruit.

Banana is from the Musaceae family. Banana does not need any special care. Special care is applied in the commercial cultivation of bananas. With special care, the productivity of the banana increases.

In the banana plant, its fruit begins to appear green at the beginning of summer. Banana fruit is in clusters. There are about 10-15 bananas in each cluster. The homeland of bananas is known as India, Australia and China. It has spread to the world from here.

Banana is grown by seed or bottom shoots. The seedlings grown in this way are then planted in their real place. It can be very developed or weak depending on the condition of the seedling. The best time for planting banana seedlings is between March and May. After the banana planting is done, irrigation should be done very well. Drip irrigation is the most suitable method for bananas. With drip irrigation, productivity increase has been achieved both in terms of water. Banana is very productive in soils rich in organic matter.

Banana is a perennial plant. The part of the banana plant that is under the ground is called the tuber, and the part that is above the ground is called the stem. Depending on the type of banana plant, the stem length can grow from 1-2 meters to 5-6 meters. After the development of the leaves of the banana plant is completed, buds are formed. These buds are in the form of clusters. The harvest time of the buds is between 75-115 days.

There is no certain difference in taste in banana varieties. Banana varieties are mostly classified by their size. The short banana variety is called the dwarf Cavendish. The short banana is approximately 1.5 meters tall. The medium banana variety is grand nain and the tall banana variety is Williams.

The cutting-edge technology in the classification process is deep learning. Many classifications have been made with deep learning. Tan et al. studied on object detection in their work. Object detection and object tracking studies in deep learning were examined. He gave information about the definition and types of deep learning. He gave information about the architectures used in deep learning. Found a review on object tracking. The architectures used in object tracking are examined. He gave information about the libraries used in deep learning (Tan et al. 2021).

Sevi have worked on classification with deep learning. In their study, they classified the railway fasteners. Classification of rail, fastener and traverse has been done with deep learning. Different architectures were used in this study. They achieved 94% accuracy in their studies (Sevi et al. 2022).

Artificial intelligence is not only applied in the field of science and engineering. Uzun et al. have studied the relationship between artificial intelligence and culture and art. With these studies, they have shown that artificial intelligence will be used in all areas of life (Uzun et al. 2021).

Ağdaş et al. tried to detect weapons and knives in their work. In these studies, they worked on security camera images. They used deep learning in their work. They preferred YOLO architecture in deep learning. They used 5078 images in their work. Of these images, there are 3000 weapons and 2078 knives. They used five variants of YOLO architecture in their work. They achieved an accuracy of 97.6% in their studies (Ağdaş et al. 2022).

In the study, first grown banana fruit was collected. This banana fruit is green in color. The ripening time of the banana was monitored. During this period, the data set was created by taking photographs. 250 photographs were taken at five different ripening stages of the banana. A dataset consisting of 125 photographs in total was created. The created data set was classified in the deep learning algorithm. AlexNet architecture is used for classification process. After the classification process, an accuracy of 97.8% was obtained.

2. Material and Method

2.1. Deep Learning

Deep learning is predicting results with a given set. There are multiple layers for this. Deep learning is a type of machine learning. Deep learning is closely related to artificial intelligence and machine learning. Figure 2.1 shows the relationships between artificial intelligence, machine learning and deep learning.

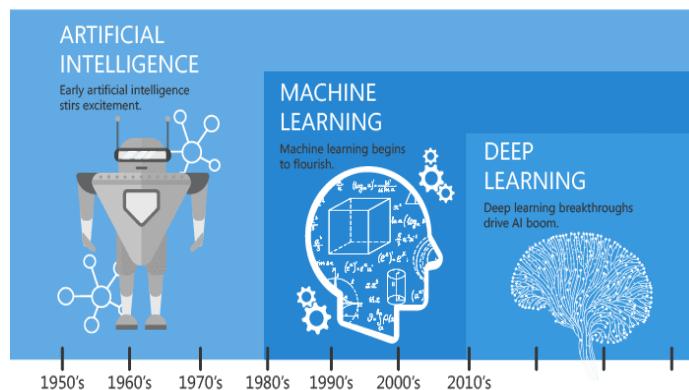


Figure 2.1 Relationship between artificial intelligence, machine learning and deep learning (Natarajan 2019).

Artificial intelligence emerged in the 1950s (Bu et al. 2019). Artificial intelligence imitates human intelligence to perform given tasks. Artificial intelligence can improve itself with the data it collects (Coulibaly et al. 2022). The biggest contribution of artificial intelligence as a technology is to imitate human intelligence. Artificial intelligence gave way to machine learning in the 1980s (Meshram et al. 2020).

Machine learning is a sub-branch of artificial intelligence. Machine learning is divided into three as supervised, unsupervised and semi-supervised. Supervised machine learning is the most widely used type of machine learning. With supervised machine learning, it is taught which result should be reached. Supervised machine learning is like a child. Supervised machine learning looks at pictures of fruit from a book and tries to memorize them. Supervised machine learning attempts to learn from rote. Supervised machine learning is primarily multi-classification. After supervised machine learning, regression is also used in support vector learning.

Another type of machine learning is unsupervised machine learning. Unsupervised machine learning learns with a more independent approach than supervised machine learning. In unsupervised machine learning, it is based on data that has no specific and defined output. Unsupervised machine learning makes learning to group more advanced than rote learning in child learning.

Semi-supervised machine learning is between supervised and unsupervised machine learning. Semi-supervised machine learning uses smaller datasets during training. In this way, it makes feature separation in classification during training. Semi-supervised machine learning is used in classifications that do not have sufficient datasets.

2.2. AlexNet

AlexNet is an architecture used in convolutional neural networks. He won the first place in the LSVRC (Large Scale Visual Recognition Challenge) competition in 2012. In the LSVRC competition, teams competed to achieve higher accuracy. Large datasets were used in the competition (Tetilia et al. 2022). Figure 2.2 shows the AlexNet architecture.

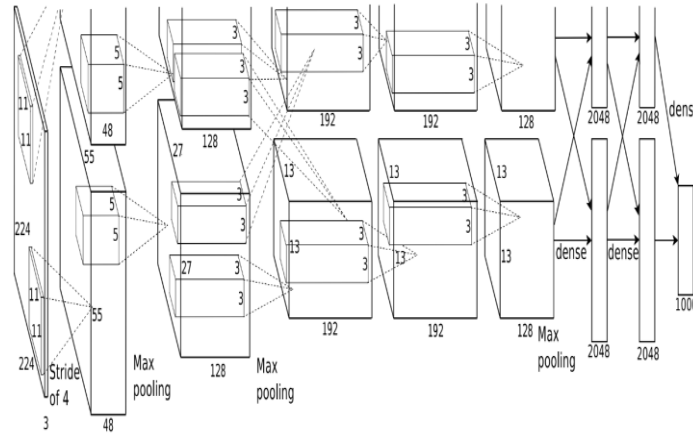


Figure 2.2 AlexNet architecture (Gayani et al. 2020).

AlexNet architecture consists of eight layers. Five of these layers are folded layers. There are three fully link layers in the AlexNet architecture. As a result of each layer, 1000 classifications can be made. There is a softmax layer for this. AlexNet architecture uses 224 x 224 x 3-layer images as input. 11 x 11 filter is applied in the first layer. At the end of the first layer, 48 images are obtained. Max-pooling is applied after the first, second and fifth layers in AlexNet architecture.

Pooling is a feature used in convolutional neural networks. With this feature, a filter is applied on the picture. With this application reveals the features of the picture. Maximum pooling is the most commonly used pooling. Figure 2.3 shows the maximum pooling.



Figure 2.3 Max pooling.

ReLU (Rectified Linear Unit) is used as activation in AlexNet architecture. In other architectures, linear, tanh and sigmoid are preferred. The biggest reason for choosing ReLU is that it is fast. The process is reduced by the fact that it is fast during the training. Sigmoid, tanh and linear activations are slow compared to ReLU. Another reason for ReLU activation is that the function goes to zero as it increases or decreases. The result of the derivative going to zero causes the vanishing gradient problem. Vanishing gradient is an undesirable situation in deep learning. Figure 2.4 shows the activation types used in deep learning architectures.

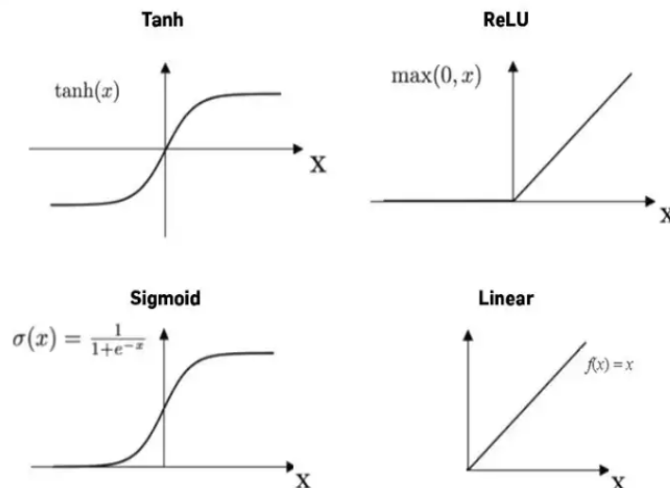


Figure 2.4 Tanh, ReLU, Sigmoid and Linear activation (Junxi 2019).

2.3. Data set

Bananas are green when first plucked. It turns yellow as it matures. In this study, the ripening stages of the banana were determined. Pictures were taken of this from the first picking of the banana until it ripened. Figure 2.5 shows seven different versions of banana images used in the data set.



Figure 2.5 Pictures of bananas used in the data set.

3. Results and Discussion

It was taken in high resolution while creating the data set. AlexNet architecture uses $256 \times 256 \times 3$ images. For this, all images used in the data set have been changed. As a result of the preparation of the data set, the classification process was carried out in AlexNet architecture. The classification process was carried out in steps. First, the image format was checked. Then the first filters were applied. Figure 3.1 shows the operation of the AlexNet architecture.

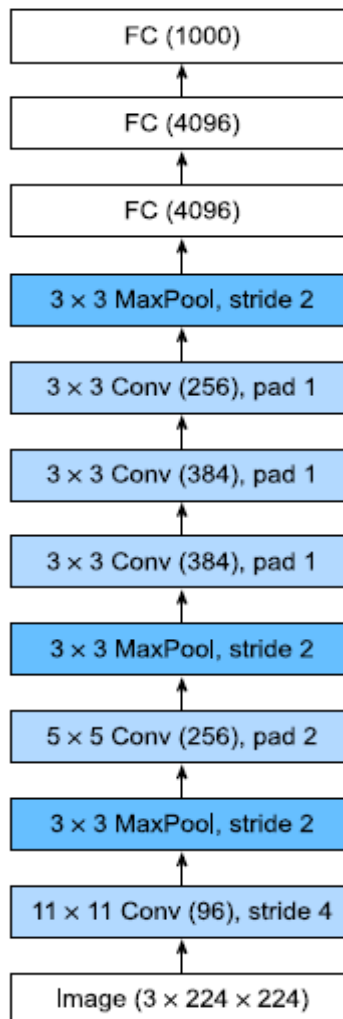


Figure 3.1 AlexNet architecture work.

In the AlexNet architecture, the first filter is made in 11 x 11 dimensions. Figure 3.2 shows the first filter output used in the AlexNet architecture.

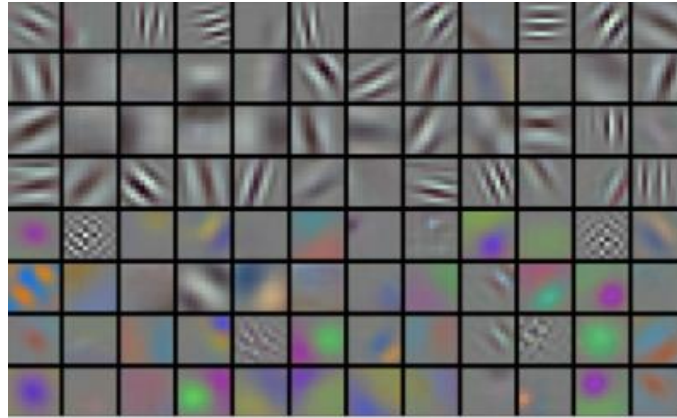


Figure 3.2 First filtering result (Ishaa 2019).

As a result of classification, an accuracy of 96.63% was obtained. Figure 3.3 shows the classification result.

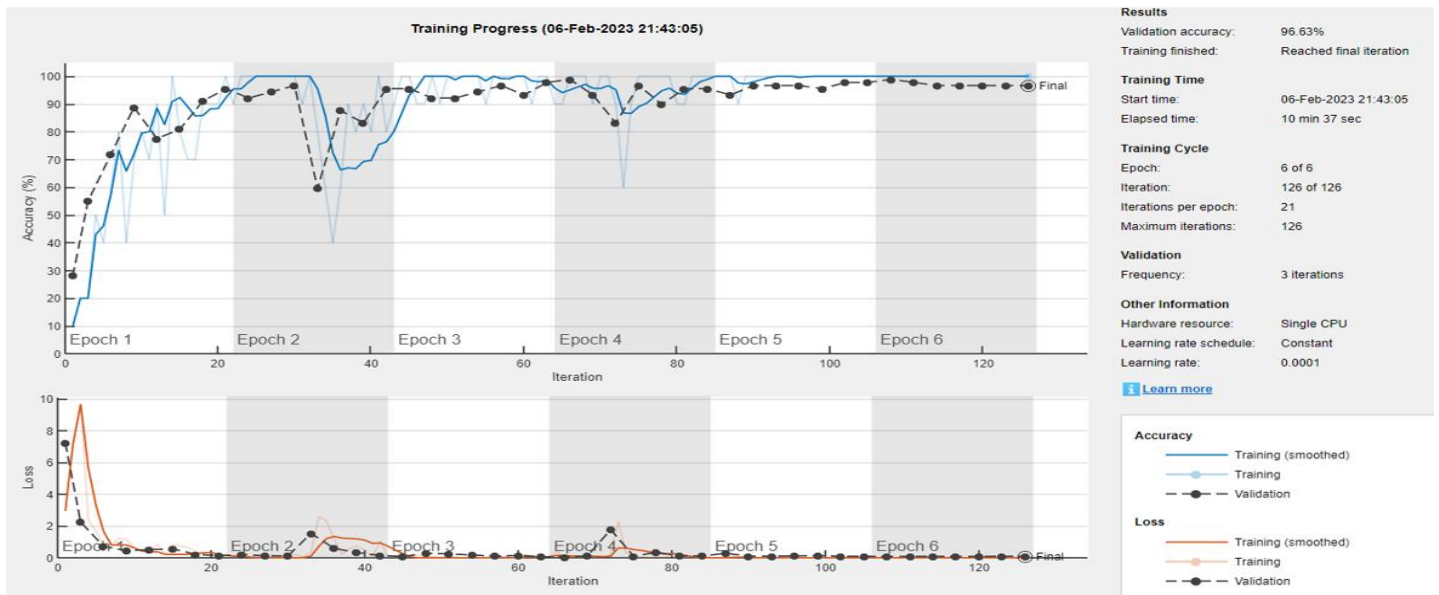


Figure 3.3 First filtering result.

4. Conclusions and Recommendations

Banana fruit is collected as green. As it starts to become a banana, its color changes from green to yellow. In this study, the ripening stages of banana fruit were determined. For this, the banana fruit is collected as green. Pictures were taken until maturation occurred. The data set was created with these pictures. The dataset consists of 700 images. The maturation phase consists of seven parts. Deep learning was used to classify banana stages. AlexNet architecture is used in the deep learning algorithm. As a result of the study, an accuracy of 96.63% was obtained. With deep learning, the ripening stages of the banana plant were determined. Thus, it will be possible to automate the ripening of the banana plant. In this way, it will be possible to increase productivity in the ripening stages of the banana.

References

- Ağdaş, M. T., & Gülseçen, S. (2022). Automatic Weapon and Knife Detection System on Security Cameras: Comparative YOLO Models. *European Journal of Science and Technology*. 41, 16-22.
- Bu, F., & Wang, X. (2019). A Smart Agriculture IoT system Basic on Deep Learning Reinforcement Learning. *Future Generation Computer System*. 99, 500- 507.
- Chen, H., Chen, A., Xu, L., Xie, H., Qioa, H., Lin, Q., & Cai, K. (2020). A Deep Learning CNN Achitecture Applied in Smart Near-Inferad Analysis of Water Population for Agricultural Irrigation Resources. *Agricultural Water Managemant*. 240, 1-8,
- Coulibaly, S., Kamsu B., & Kamissoko, D. (2022). Deep Learning for Precision Agriculture: A Bibliomtric Analysis. *Intelligent System with Application*. 16,1-18.
- Gayani C, Kokul T, & Amalka P, A (2020). Comprehensive Study on Deep Image Classification with Small Datasets

- Junxi F, Xiohai H, Qizhi T, Chao R, Honggang C, Yang L, (2019). Reconstruction of porous media from extremely limited information using conditional generative adversarial networks. *Physical Review E* 100, 033308
- Isha G, Priyadarshini P, Kaushik R, (2019). A Low Effort Approach to Structured CNN Design Using PCA. *IEEE Access*, 1-12.
- Natarajan S, (2019). Artificial Intelligence (AI) vs. Machine Learning vs. Deep Learning
- Meshram, V., Patil, K., Meshram, V., Hanchate, D., & Ramkteke, S, D. (2020). Machine Learning in Agricultere Domain: A State of Art Survey. *Artifical Intelligance in Thre Life Science. 1*, 1-11.
- Uzun, Y., Akkuzu, B., & Kayırcı, M. (2021). The Relationship of Articaial Intelligence to Culture Art. *European Journal of Science and Tecnology. 28*, 753-757.
- Sevi, M., Aydın, İ., & Karaköse, M. (2022). Classification of Railway Fasteners by Deep Learning Methods. *European Journal of Science and Tecnology. 35*, 268-274.
- Tan, F, G., Yüksel, A, S., Aydemir, E., & Ersoy, M. (2021). A Rview On Object Detection and Tracking with Deep Learning Technique. *European Journal of Science and Tecnology. 25*, 157-171.
- Tetilia, E, C., Machoda, B, B., Astolfi, G., Belete, N, A, S., Amorin, W, P., Roel, A, R., & Pistori, H. (2020). Dedection and Classification of Soybean Pets using Deep Learning with UAV Images. *Computer and Electronics in Agriculture. 179*, 1-11.