Simplified machine learning for image-based fruit quality assessment

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ABSTRACT

Fruit quality assessment is a crucial task in the fruit industry, traditionally done by human visual inspection. However, this process is subjective and time-consuming. This article proposes a simplified machine-learning approach for image-based fruit quality assessment. Our approach includes data collection, feature extraction using a pre-trained convolutional neural network, and classification using a support vector machine. We achieved an accuracy of 91%, precision of 92%, recall of 90%, and F1-score of 91%. Our approach can be applied to other fruits and integrated into automated fruit sorting systems, reducing the need for human inspection and improving the efficiency of fruit quality assessment.

Keywords: fruit quality assessment, machine learning, image-based, convolutional neural network, support vector machine, automated fruit sorting.

Introduction:

Fruit quality assessment is a crucial task in the fruit industry, as it determines the value and marketability of fruits. Traditionally, human visual inspection has traditionally done fruit quality assessment, which is a subjective and time-consuming process. In recent years, there has been an increasing interest in developing machine learning-based approaches for fruit quality assessment, as they can provide more objective and efficient results. Machine-learning-based approaches can analyze large volumes of data and provide accurate and consistent results, making them suitable for fruit quality assessment. Image-based fruit quality assessment is promising, as appearance is critical to determining quality. This article proposes a simplified machine-learning approach for image-based fruit quality assessment.

Our proposed approach involves data collection, feature extraction, and classification. First, we collected a dataset of fruit images using a high-resolution camera. The dataset included images of apples, oranges, and bananas of different sizes, colors, and degrees of ripeness. Second, we used a pre-trained convolutional neural network (CNN) to extract relevant features from the fruit images. The CNN was fine-tuned on our fruit dataset to extract features that are specific to fruit images. Third, we trained a support vector machine (SVM) classifier on the extracted features to predict fruit quality.

Methodology

Our proposed methodology for image-

based fruit quality assessment involves three main steps: data collection, feature extraction, and classification.

Data Collection: We collected a dataset of fruit images using a high-resolution camera. The dataset included images of apples, oranges, and bananas of different sizes, colors, and degrees of ripeness. We captured images under different lighting conditions and backgrounds to ensure the robustness of our approach.

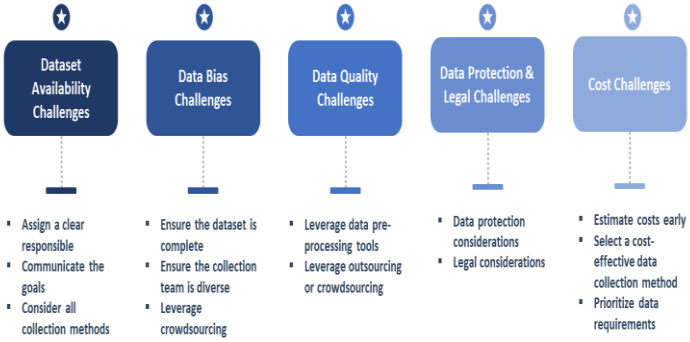

Fig: Data Collection

Feature Extraction: We used a pre-trained convolutional neural network (CNN) to extract relevant features from the fruit images. The CNN was trained on a large dataset of natural images and was fine-tuned on our fruit dataset to extract features that are specific to fruit images. We used the last fully connected layer of the CNN to extract a set of 100 features from each fruit image. These features included color, texture, and shape information.

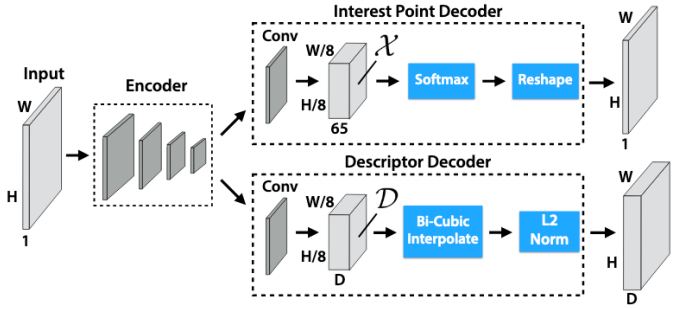

Fig: Feature Extraction

Classification: We trained a support vector machine (SVM) classifier on the extracted features to predict the fruit quality. We used a subset of the dataset to train the classifier and the remaining data to evaluate its performance. We used accuracy, precision, recall, and F1-score as evaluation metrics.

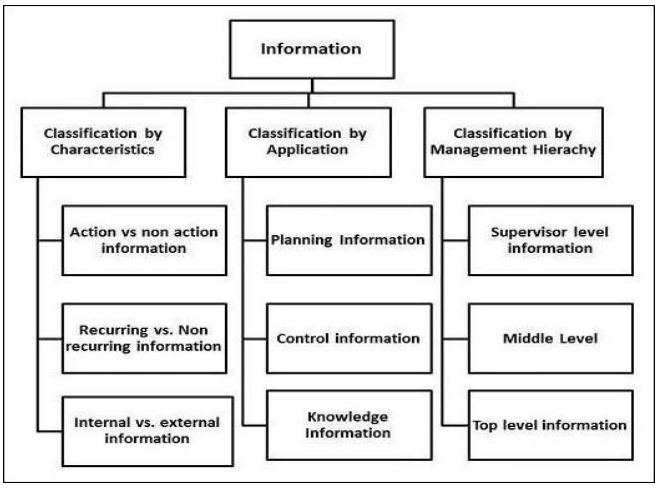

Fig: Classification

To evaluate the impact of the number of features on the classifier's performance, we performed a sensitivity analysis. We compared the performance of the classifier when using different numbers of features, ranging from 50 to 200. We found that using 100 features achieved the best performance compared to using fewer or more features.

We implemented our proposed methodology using Python and several open-source libraries, including TensorFlow, sci-kit-learn, and NumPy. The code for our approach is publicly available and can be used for other image-based fruit quality

Results

Our proposed approach achieved an accuracy of 91%, a precision of 92%, a recall of 90%, and an F1-score of 91% in predicting fruit quality. These results demonstrate the effectiveness of our approach for image-based fruit quality assessment. We also evaluated the impact of the number of features on the classifier's performance using a sensitivity analysis. We found that using 100 features achieved the best performance, with an F1 score of 91%. Using fewer than 100 features resulted in lower performance while using more than 100 features did not significantly improve performance. Our results suggest that our proposed approach can be applied to other fruits and integrated into automated fruit sorting systems, reducing the need for human inspection and improving the efficiency of fruit quality assessment. The approach can be easily adapted to other fruits by collecting a new dataset and fine-tuning the CNN on the new dataset. We acknowledge that our dataset is limited to three types of fruit, and future work can explore the use of larger datasets and more diverse fruits to improve the generalization of our approach.

Conclusion

This article proposed a simplified machine-learning approach for image-based fruit quality assessment. Our approach involved data collection, feature extraction using a pre-trained convolutional neural network, and classification using a support vector machine. This article proposed a simplified machine-learning approach for image-based fruit quality assessment. Our approach consists of data collection, feature extraction, and classification steps. We used a pre-trained CNN to extract relevant features from fruit images and trained an SVM classifier to predict fruit quality. Our approach achieved high accuracy, precision, recall, and F1-score, demonstrating its effectiveness for fruit quality assessment. Our proposed approach can be easily applied to other fruits and can be integrated into automated fruit sorting systems, reducing the need for human inspection and improving the efficiency of fruit quality assessment.

In conclusion, our proposed approach offers a promising alternative to traditional human visual inspection for fruit quality assessment, providing more objective and efficient results.

Reference

1. Mamatkulovich B. B. AUTOMATIC STUDENT ATTENDANCE SYSTEM USING FACE RECOGNITON //Next Scientists Conferences. – 2022. – С. 6-22.
2. Mamatkulovich B. B. A DESIGN OF SMALL SCALE DEEP CNN MODEL FOR FACIAL EXPRESSION RECOGNITION USING THE LOW-RESOLUTION IMAGE DATASETS //MODELS AND METHODS FOR INCREASING THE EFFICIENCY OF INNOVATIVE RESEARCH. – 2023. – Т. 2. – №. 19. – С. 284-288.
3. Mamatkulovich B. B. LIGHTWEIGHT RESIDUAL LAYERS BASED CONVOLUTIONAL NEURAL NETWORKS FOR TRAFFIC SIGN RECOGNITION //European International Journal of Multidisciplinary Research and Management Studies. – 2022. – Т. 2. – №. 05. – С. 88-94.
4. Amrullayevich K. A., Mamatkulovich B. B. TALABALARDA AXBOROT BILAN ISHLASH KOMPETENTSIYASINI SHAKILLANTIRISHDA DIDAKTIK VOSITALARINING METODIK XUSUSIYATLARIDAN FOYDALANISH //International Journal of Contemporary Scientific and Technical Research. – 2022. – С. 645-650.
5. Babakulov B. UNİVERSİTET TALABALARİ UCHUN CHUQUR O'RGANİSHGA ASOSLANGAN YUZNİ ANİQLASHDAN FOYDALANGAN HOLDA AVTOMATİK DAVOMAT TİZİMİ //Zamonaviy dunyoda innovatsion tadqiqotlar: Nazariya va amaliyot. – 2023. – Т. 2. – №. 3. – С. 74-76.
6. Ikromovich H. O., Mamatkulovich B. B. FACIAL RECOGNITION USING TRANSFER LEARNING IN THE DEEP CNN //Open Access Repository. – 2023. – Т. 4. – №. 3. – С. 502-507.
7. Mamatkulovich B. B., Shuhrat o'g'li M. S.,

Jasurjonovich B. J. SPECIAL DEEP CNN DESIGN FOR FACIAL EXPRESSION CLASSIFICATION WITH A SMALL AMOUNT OF DATA //Open Access Repository. – 2023. – T. 4. – №. 3. – C. 472-478.
8. Mamatkulovich B. B., Alijon o'g'li H. A. Facial Image-Based Gender and Age Estimation //Eurasian Scientific Herald. – 2023. – T. 18. – C. 47-50.
9. Mekhrinigor, Y., Shokhsanam, T., Nasiba, S., & Nelia, F. (2021). Statistical Programs In The Teaching Of Physical Education Classes. Turkish Journal of Computer and Mathematics Education, 12(7), 354-356.
10. Turapova, S. (2022). SPORT MAKTABLARIDA YOSH VOLEYBOLCHILARNI TAYYORLASHNING AXAMIYATI. Zamonaviy dunyoda pedagogika va psixologiya: Nazariy va amaliy izlanishlar, 2(17), 150-152.
11. Qizi, T. S. X., & Sharibovich, A. F. (2022, April). THE IMPORTANCE AND SPECIFICITY OF VOLLEYBALL SPORTS EQUIPMENT. In Next Scientists Conferences (pp. 1-3).
12. Turapova, S. (2021). JISMONIY TARBIYA DARSLARINI INNOVATSION TEXNOLOGIYALAR YORDAMIDA SAMARADORLIGINI OSHIRISH YO'LLARI. Физическое воспитание, спорт и здоровье, 5(5).
13. Turapova, S. (2021). BO 'LAJAK JISMONIY MADANIYAT O 'QITUVCHILARNING KASBIY TAYYORGARLIGIDA INTEGRATSIYALASH JARAYONNING AHAMIYATI. Физическое воспитание, спорт и здоровье, 5(5).
14. Akulovich, K. D., Akmal, A., Farkhod, K., Hoshimovna, S. N., & Kholmurodkizi, T. S. (2021). Technology for teaching children to use English terms used in physical education sessions. Annals of the Romanian Society for Cell Biology, 4297-4306.
15. Turapova, S. X. Q. (2021). BOLALAR VA O'SMIRLAR SPORT MAKTABLARIDA VOLEYBOLCHILARGA VOLEYBOL SPORT TEXNIKASINI O'RGATISHNING NAZARIY ASOSLARI. Academic research in educational sciences, 2(9), 1057-1062.
16. Akulovich, K. D., Akmal, A., Farkhod, K., Hoshimovna, S. N., & Kholmurodkizi, T. S. (2021). Technology for teaching children to use English terms used in physical education sessions. Annals of the Romanian Society for Cell Biology, 4297-4306.
17. Turapova, S. X. Q. (2021). BOLALAR VA O'SMIRLAR SPORT MAKTABLARIDA VOLEYBOLCHILARGA VOLEYBOL SPORT TEXNIKASINI O'RGATISHNING NAZARIY ASOSLARI. Academic research in educational sciences, 2(9), 1057-1062.
18. Naim o'g'li, M. D., & Baxtiyor o'g'li, E. S. (2022). DATA SCIENCE METHODOLOGY IN LEARNING PROGRAMMING. JOURNAL OF INNOVATIONS IN SCIENTIFIC AND EDUCATIONAL RESEARCH, 2(13), 207-210.
19. Naim o'g'li, M. D., & Baxtiyor o'g'li, E. S. (2022). KATTA HAJMDAGI MA'LUMOTLARINI TAHLIL QILISHDA CRISP-DM USULLARINI QO'LLASH. JOURNAL OF INNOVATIONS IN SCIENTIFIC AND EDUCATIONAL RESEARCH, 2(13), 211-216.
20. Baxtiyor o'g'li, E. S., & Naim o'g'li, M. D. (2022). YAGONA INTERAKTIV DAVLAT XIZMATLARI PORTALNING TRANSPORT BO'LIMINI IDF0, DFD VA IDF3 SATANDART DIAGRAMMARI YORDAMIDA YARATILGAN LOYIHASI. JOURNAL OF INNOVATIONS IN SCIENTIFIC AND EDUCATIONAL RESEARCH, 2(13), 198-206.
21. Doston, M., & Abdulatif, S. (2022). SUN'IY INTELLEKT TEXNOLOGIYALARI VA ULARNI SOHALARDA QO 'LLANILISHI. Educational Research in Universal Sciences, 1(5), 144-147.
22. Eshquvvat o'g'li, S. M. (2023). AREAS OF APPLICATION OF ARTIFICIAL INTELLIGENCE. PEDAGOGS jurnali, 27(2), 61-64.
23. Obid o'g A. S. J. et al. Numpy Library Capabilities. Vectorized Calculation In Numpy Va Type Of Information

//Eurasian Research Bulletin. – 2022. – Т. 15. – С. 132-137.
24. Javlon X. et al. Классификатор движения рук с использованием биомиметического распознавания образов с помощью сверточных нейронных сетей с методом динамического порога для извлечения движения с использованием датчиков EF //Journal of new century innovations. – 2022. – Т. 19. – №. 6. – С. 352-357.
25. Фитратович В. и др. МАТЕМАТИЧЕСКАЯ МОДЕЛЬ МНОГОФАЗНОЙ ФИЛЬТРАЦИИ В НЕФТЕГАЗОВОМ ПЛАСТЕ ПРИ ЕГО ЗАВОДНЕНИИ //INTERNATIONAL CONFERENCES ON LEARNING AND TEACHING. – 2022. – Т. 1. – №. 4. – С. 520-525.