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ADVANCING AGRICULTURE THROUGH IMAGE-BASED DATASETS IN PLANT SCIENCE: A REVIEW

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ABSTRACT
Image-based datasets have become increasingly important in plant science, where they are used to study plant morphology, growth, and development, as well as to detect and monitor plant diseases and stress. The use of image-based datasets in plant science has significantly expanded in recent years, as advances in technology have made it possible to collect and process vast amounts of visual data from various sources, including remote sensing, drones, and mobile devices. The importance of image-based datasets in plant science lies in their ability to provide high-resolution and detailed information about plants, enabling researchers to study plant traits and processes in a non-destructive and non-invasive manner. Image-based datasets are also valuable for developing machine learning models that can detect and classify plant species, identify plant diseases and stress, and predict plant growth and yield. Looking ahead, the future benefits of image-based datasets in plant science are immense. The use of image-based datasets has the potential to significantly improve our understanding of plant biology and ecology, leading to the development of more sustainable and efficient agricultural practices. Image-based datasets can also be used to monitor plant health and predict crop yields, enabling farmers to make more informed decisions about irrigation, fertilization, and pest control. However, to realize these benefits, it will be crucial to address several challenges, including the need for more standardized and high-quality image datasets, as well as the development of more accurate and robust machine learning algorithms that can effectively learn from these datasets. Despite these challenges, the use of image-based datasets in plant science is poised to revolutionize the field, providing researchers and practitioners with new tools to address some of the most pressing challenges facing agriculture and plant biology.

KEYWORDS: *Image-based datasets, Plant science, Plant morphology, Growth, Development, Plant diseases*

INTRODUCTION

The field of plant science has significantly expanded in recent years with the advent of advanced technology and data analysis techniques. In particular, the use of image-based datasets has become increasingly important in studying plant morphology, growth, and development, as well as detecting and monitoring plant diseases and stress. Image-based datasets provide detailed and high-resolution information about plants, enabling researchers to study plant traits and processes in a non-destructive and non-invasive manner. Additionally, the use of machine learning models on these datasets has enabled researchers to detect and classify plant species, identify plant diseases and stress, and predict plant growth and yield [1-5].

This paper explores the importance of image-based datasets in plant science and their potential to revolutionize the field. We examine the various sources of image-based datasets, including remote sensing, drones, and mobile devices, and the challenges associated with the development of more standardized and high-quality datasets. We also discuss the need for more accurate and robust machine learning algorithms to effectively learn from these datasets.

We explore the future benefits of image-based datasets in plant science, including the potential to improve our understanding of plant biology and ecology, leading to the development of more sustainable and efficient agricultural practices. Image-based datasets can also be used to monitor plant health and predict crop yields, enabling farmers to make more informed decisions about irrigation, fertilization, and pest contro[5-10].

The use of image-based datasets in plant science presents exciting opportunities for researchers and practitioners to address some of the most pressing challenges facing agriculture and plant biology. By leveraging the power of advanced technology and data analysis techniques, we can improve our understanding of plant traits and processes, develop more sustainable and efficient agricultural practices, and ultimately, enhance food security for the growing global population.

THE IMPORTANCE OF UNDERSTANDING DATASETS, AI, AND MACHINE LEARNING IN PLANT SCIENCE

The field of plant science is experiencing significant advancements as a result of technological innovations and sophisticated data analysis techniques. Central to these developments are the concepts of datasets, artificial intelligence (AI), and machine learning. Datasets refer to vast collections of organized and structured data that provide a foundation for analysis and interpretation. AI is a computer system designed to perform tasks that would normally require human intelligence, such as learning, problem-solving, and decision-making. Machine learning is a subset of AI that involves the use of algorithms that can learn from data and improve their performance over time. In the context of plant science, image-based datasets have become particularly valuable, providing detailed and high-resolution information about plants. By utilizing AI and machine learning algorithms on these datasets, researchers can detect and classify plant species, identify plant diseases and stress, and predict plant growth and yield. These techniques have the potential to significantly enhance our understanding of plant biology and ecology, leading to the development of more sustainable and efficient agricultural practices. Furthermore, AI and machine learning can provide valuable insights into how plants respond to environmental stress, enabling researchers to devise strategies to mitigate the impact of climate change on agriculture [10-20].

The concepts of datasets, AI, and machine learning are central to the development of innovative solutions in plant science. The integration of these concepts provides a powerful framework for advancing our understanding of plant biology and ecology, as well as for the development of sustainable and efficient agricultural practices [20-25].

IMPORTANCE OF IMAGE DATASET

Image-based datasets have become increasingly important in the field of plant science due to their ability to provide detailed and high-resolution information about plants. These datasets enable researchers to study plant morphology, growth, and development, as well as to detect and monitor plant diseases and stress. One of the significant advantages of image-based datasets is that they can be collected in a non-destructive and non-invasive manner, making them an ideal tool for studying plant traits and processes. Additionally, advances in technology, such as remote sensing, drones, and mobile devices, have made it possible to collect and process vast amounts of visual data from various sources. Image-based datasets are crucial for the development of machine learning models that can detect and classify plant species, identify plant diseases and stress, and predict plant growth and yield. These models can analyze large datasets quickly and efficiently, providing accurate and reliable results. Machine learning algorithms can learn from these datasets, improving their performance over time, and providing valuable insights into plant biology and ecology. The use of image-based datasets in plant science has significant implications for agriculture. They can be used to monitor plant health and predict crop yields, enabling farmers to make more informed decisions about irrigation, fertilization, and pest control. With the increasing demand for sustainable and efficient agricultural practices, image-based datasets have the potential to play a vital role in addressing some of the most pressing challenges facing agriculture and plant biology. They can help develop new plant varieties that are more resilient to environmental stresses, optimize resource use, and reduce the need for harmful pesticides and fertilizers. To realize these benefits, it is crucial to address several challenges, including the need for more standardized and high-quality image datasets and the development of more accurate and robust machine learning algorithms. These challenges can be addressed through collaborations between plant scientists, engineers, and data scientists, who can work together to develop innovative solutions that can advance our understanding of plant biology and ecology [26-32].

The importance of image-based datasets in plant science is immense. These datasets provide a powerful tool for studying plant biology and ecology, developing sustainable agricultural practices, and improving crop yields. As technology advances and more data becomes available, the use of image-based datasets is poised to revolutionize the field, providing new tools and insights into plant biology and ecology that will have far-reaching implications for agriculture and the environment [33,34].

CHALLENGES AND OPPORTUNITIES

Image-based datasets offer tremendous opportunities in plant science, from studying plant morphology and growth to detecting and monitoring plant diseases and stress. However, several challenges must be addressed to realize the full potential of these datasets. One of the primary challenges is the need for more standardized and high-quality image datasets. The accuracy and reliability of machine learning models depend on the quality of the data they are trained on. Therefore, it is essential to collect high-quality images and ensure that they are labeled correctly to avoid biased results. Another significant challenge is the development of more accurate and robust machine learning algorithms that can effectively learn from these datasets. Machine learning algorithms must be trained to recognize patterns and anomalies in plant images accurately. However, this can be challenging, as plants can vary significantly in their appearance, making it difficult to identify all relevant features [35-40].

Additionally, data privacy and security can be a challenge when using image-based datasets, as they can contain sensitive information about plant species, location, and growth patterns. It is crucial to ensure that these datasets are handled securely and that any data sharing or collaboration is done ethically and transparently.

Despite these challenges, image-based datasets in plant science present numerous opportunities for research and innovation. These datasets can help identify plant species, detect diseases and stress, and predict plant growth and yield, leading to the development of more sustainable and efficient agricultural practices. Image-based datasets can also aid in the development of new plant varieties that are more resilient to environmental stresses, reducing the need for harmful pesticides and fertilizers. The challenges and opportunities of image-based datasets in plant science are intertwined. By addressing the challenges, we can unlock the full potential of these datasets, leading to innovative solutions that advance our understanding of plant biology and ecology and have far-reaching implications for agriculture and the environment [41-50].

CONCLUSION

The image-based datasets have become increasingly important in plant science, providing researchers and practitioners with new tools to address some of the most pressing challenges facing agriculture and plant biology. The ability to collect high-resolution and detailed information about plants in a non-destructive and non-invasive manner is a significant advantage of image-based datasets, enabling researchers to study plant traits and processes with unprecedented precision. To fully realize the benefits of these datasets, several challenges must be addressed, including the need for more standardized and high-quality image datasets, the development of more accurate and robust machine learning algorithms, and ensuring data privacy and security. By overcoming these challenges, image-based datasets can significantly improve our understanding of plant biology and ecology, leading to the development of more sustainable and efficient agricultural practices. The image-based datasets are poised to revolutionize the field of plant science, opening up new avenues of research and innovation that could have a significant impact on our society and the environment. The continued exploration and development of image-based datasets in plant science hold enormous promise for the future, and the opportunities for research and innovation in this field are limitless.

REFERENCES

1. *Chumchu, P., & Patil, K. (2023). Dataset of cannabis seeds for machine learning applications. Data in Brief, 47, 108954.*
2. *Laad, M., Kotecha, K., Patil, K., & Pise, R. (2022). Cardiac Diagnosis with Machine Learning: A Paradigm Shift in Cardiac Care. Applied Artificial Intelligence, 36(1), 2031816.*
3. *Suryawanshi, Y., Patil, K., & Chumchu, P. (2022). VegNet: Dataset of vegetable quality images for machine learning applications. Data in Brief, 45, 108657.*
4. *Pise, R., Patil, K., Laad, M., & Pise, N. (2022). Dataset of vector mosquito images. Data in Brief, 45, 108573.*
5. *Meshram, V., & Patil, K. (2022). Border-Square net: a robust multi-grade fruit classification in IoT smart agriculture using feature extraction based Deep Maxout network. Multimedia Tools and Applications, 81(28), 40709-40735.*
6. *Meshram, V., Patil, K., Meshram, V., Dhumane, A., Thepade, S., & Hanchate, D. (2022, August). Smart Low Cost Fruit Picker for Indian Farmers. In 2022 6th International Conference On Computing, Communication, Control And Automation (ICCUBEA (pp. 1-7). IEEE.*
7. *Pise, R., Patil, K., & Pise, N. (2022). Automatic Classification Of Mosquito Genera Using Transfer Learning. Journal of Theoretical and Applied Information Technology, 100(6), 1929-1940.*
8. *Bhutad, S., & Patil, K. (2022). Dataset of road surface images with seasons for machine learning applications. Data in brief, 42, 108023.*
9. *Bhutad, S., & Patil, K. (2022). Dataset of Stagnant Water and Wet Surface Label Images for Detection. Data in Brief, 40, 107752*
10. Sonawani, S., Patil, K., & Natarajan, P. (2023). *Biomedical signal processing for health monitoring applications: a review. International Journal of Applied Systemic Studies, 10(1), 44-69.*
11. *Meshram, V., Patil, K., & Chumchu, P. (2022). Dataset of Indian and Thai banknotes with annotations. Data in brief, 41, 108007.*
12. *Meshram, V., & Patil, K. (2022). FruitNet: Indian fruits image dataset with quality for machine learning applications. Data in Brief, 40, 107686.*
13. *Meshram, V., Patil, K., Meshram, V., Hanchate, D., & Ramkteke, S. D. (2021). Machine learning in agriculture domain: A state-of-art survey. Artificial Intelligence in the Life Sciences, 1, 100010.*
14. *Meshram, V. A., Patil, K., & Ramteke, S. D. (2021). MNet: A Framework to Reduce Fruit Image Misclassification. Ingénierie des Systèmes d Inf., 26(2), 159-170.*
15. *Sonawani, S., Patil, K., & Chumchu, P. (2021). NO2 pollutant concentration forecasting for air quality monitoring by using an optimised deep learning bidirectional GRU model. International Journal of Computational Science and Engineering, 24(1), 64-73.*
16. *Testani, M. V., & Patil, K. (2021). Integrating Lean Six Sigma and Design Thinking for a Superior Customer Experience.*
17. *Meshram, V., Patil, K., & Hanchate, D. (2020). Applications of machine learning in agriculture domain: A state-of-art survey. Int. J. Adv. Sci. Technol, 29, 5319-5343.*
18. *Meshram, V. V., Patil, K., Meshram, V. A., & Shu, F. C. (2019). An astute assistive device for mobility and object recognition for visually impaired people. IEEE Transactions on Human-Machine Systems, 49(5), 449-460.*
19. *Patil, K., Laad, M., Kamble, A., & Laad, S. (2019). A consumer-based smart home with indoor air quality monitoring system. IETE Journal of Research, 65(6), 758-770.*
20. *Patil, K., Jawadwala, Q., & Shu, F. C. (2018). Design and construction of electronic aid for visually impaired people. IEEE Transactions on Human-Machine Systems, 48(2), 172-182.*
21. *Patil, K., Laad, M., Kamble, A., & Laad, S. (2018). A consumer-based smart home and health monitoring system. International Journal of Computer Applications in Technology, 58(1), 45-54.*
22. *Shah, R., & Patil, K. (2018). A measurement study of the subresource integrity mechanism on real-world applications. International Journal of Security and Networks, 13(2), 129-138.*
23. *Shah, R. N., & Patil, K. R. (2017). Securing third-party web resources using subresource integrity automation. International Journal on Emerging Trends in Technology, 4(2), 5.*
24. *Patil, K. (2017). An insecure wild web: A large-scale study of effectiveness of web security mechanisms. Vishwakarma Institute of Information Technology, Pune.*
25. *Kawate, S., & Patil, K. (2017). Analysis of foul language usage in social media text conversation. International Journal of Social Media and Interactive Learning Environments, 5(3), 227-251.*
26. *Kawate, S., & Patil, K. (2017). An Approach For Reviewing And Ranking The Customers'reviews Through Quality Of Review (QoR). ICTACT Journal on Soft Computing, 7(2).*
27. *Patil, K. (2017). Isolating malicious content scripts of browser extensions. International Journal of Information Privacy, Security and Integrity, 3(1), 18-37.*
28. *Jawadwala, Q., & Patil, K. (2016, December). Design of a novel lightweight key establishment mechanism for smart home systems. In 2016 11th International Conference on Industrial and Information Systems (ICIIS) (pp. 469-473). IEEE.*
29. *Patil, K. (2016). Preventing click event hijacking by user intention inference. ICTACT Journal on Communication Technology, 7(4), 1408-1416*
30. *Shah, R., & Patil, K. (2016). Evaluating effectiveness of mobile browser security warnings. ICTACT Journal on Communication Technology, 7(3), 1373-1378.*

31. *Patil, K., & Frederik, B. (2016). A Measurement Study of the Content Security Policy on Real-World Applications. Int. J. Netw. Secur., 18(2), 383-392.*
32. *Patil, D. K., & Patil, K. (2016). Automated Client-side Sanitizer for Code Injection Attacks. International Journal of Information Technology and Computer Science, 8(4), 86-95.*
33. *Patil, K. (2016). Request dependency integrity: validating web requests using dependencies in the browser environment. International Journal of Information Privacy, Security and Integrity, 2(4), 281-306.*
34. *Meshram, V., Meshram, V., & Patil, K. (2016). A survey on ubiquitous computing. ICTACT Journal on Soft Computing, 6(2), 1130-1135.*
35. *Patil, D. K., & Patil, K. (2015). Client-side automated sanitizer for cross-site scripting vulnerabilities. International Journal of Computer Applications, 121(20), 1-7.*
36. *Omanwar, S. S., Patil, K., & Pathak, N. P. (2015). Flexible and fine-grained optimal network bandwidth utilization using client side policy. International Journal of Scientific and Engineering Research, 6(7), 692-698.*
37. *Kurle, A. S., & Patil, K. R. (2015). Survey on privacy preserving mobile health monitoring system using cloud computing. International Journal of Electrical, Electronics and Computer Science Engineering, 3(4), 31-36.*
38. *Dong, X., Patil, K., Mao, J., & Liang, Z. (2013, July). A comprehensive client-side behavior model for diagnosing attacks in ajax applications. In 2013 18th International Conference on Engineering of Complex Computer Systems (pp. 177-187). IEEE.*
39. *Patil, K., Vyas, T., Braun, F., Goodwin, M., & Liang, Z. (2013, July). Poster: UserCSP-user specified content security policies. In Proceedings of Symposium on Usable Privacy and Security (pp. 1-2).*
40. *Patil, K., Dong, X., Li, X., Liang, Z., & Jiang, X. (2011, June). Towards fine-grained access control in javascript contexts. In 2011 31st International Conference on Distributed Computing Systems (pp. 720-729). IEEE.*
41. *Shaikh, M. N., Suryawanshi, Y. C., & Mokat, D. N. (2019). Volatile profiling and essential oil yield of Cymbopogon citratus (DC.) Stapf treated with rhizosphere fungi and some important fertilizers. Journal of Essential Oil Bearing Plants, 22(2), 477-483.*
42. *Suryawanshi, Y. C., & Mokat, D. N. (2019). Chemical composition of essential oil of Madhuca longifolia var. latifolia (Roxb.) A. Chev. flowers. Journal of Essential Oil Bearing Plants, 22(4), 1034-1039.*
43. *Suryawanshi, Y. C., & Mokat, D. N. (2019). GCMS and elemental analysis of Madhuca longifolia var. latifolia seeds. Int J Pharm Sci Res, 10(3), 786-789.*
44. *Suryawanshi, Y. C. (2021). Hydroponic cultivation approaches to enhance the contents of the secondary metabolites in plants. In Biotechnological Approaches to Enhance Plant Secondary Metabolites (pp. 71-88). CRC Press.*
45. *Torawane, S. D., Suryawanshi, Y. C., & Mokat, D. N. (2020). Controlled release of functional bioactive compounds from plants. In Encapsulation of Active Molecules and Their Delivery System (pp. 103-110). Elsevier.*
46. *Suryawanshi, Y. C., & Mokat, D. N. (2021). Morphophysiological seed variability in Mahua trees from Western Ghats and its impact on tribal life. Proceedings of the National Academy of Sciences, India Section B: Biological Sciences, 91, 227-239.*
47. *Mokat, D. N., Torawane, S. D., & Suryawanshi, Y. C. (2020). Chemical profiling of two aromatic weeds, Cyathocline purpurea and Blumea lacera. Current Botany, 11, 205-210.*
48. *Kanorewala, B. Z., & Suryawanshi, Y. C. (2022). The Role of Alternate Nostril Breathing (Anuloma Viloma) Technique in Regulation of Blood Pressure. Asian Pacific Journal of Health Sciences, 9(2), 48-52.*
49. *Suryawanshi, Y., & Mokat, D. (2020). Variability studies in Madhuca longifolia var. latifolia flowers from Northern Western Ghats of India. Indian Journal of Hill Farming. 33 (2): 261, 266.*
50. *Pote, A. M., & Suryawanshi, Y. C. Importance of Naad yoga for reducing the stress.*
Naad-Nartan Journal of Dance & music. 10(2),53-58.