LIME and Grad-CAM, help in crop disease detection by making AI model predictions more transparent, showing which features or image regions contribute to disease identification, thereby improving trust and decision making in ginger disease and pest management.

E. Generative AI

Generative AI is currently being explored to overcome the limitations and scarcity faced in well-annotated datasets [99], [100]. The generative AI can generate new content, ideas, or solutions based on patterns learned from the existing data. The use of generative AI techniques, such as StyleGAN [101], a variation of generative adversarial networks [102], bidirectional encoder representations from transformers [103], and DALL-E [104] can be leveraged for disease detection in ginger plants. The use of generative AI offers the potential to generate realistic ginger disease and pest image datasets for different scenarios, thus accelerating the deployment of AIoT for ginger production.

F. Hyperspectral Imaging

The use of HSI for the early detection of nonvisible diseases in ginger plants opens up several research issues. This includes the design and development of field-portable hyperspectral technologies with minimum postprocessing, which is expected to attract several research interests. For instance, a smartphone HSI technique was presented in [105], which offers a low-cost solution with portability and user-friendly. The research on identifying the exact bands related to different diseases will pave the way for the development of specific HSI cameras for ginger diseases. This will lead to lesser costs in the acquisition of the HSI cameras. The combination of HSI with XAI is expected to attract more research interest in disease detection in ginger plants. Similar to what has been explored in [106]. These innovative approaches to assessing the quality characteristics of the rhizomes can be developed.

G. Data Collection

There is currently a lack of adequate real-world well-annotated datasets for ginger farming. Hence, more historical data are needed. This includes data related to soil conditions, environmental factors, crop health, growth patterns, field conditions, disease outbreaks, farming practices, and weather patterns. More research work is needed in the deployment of IoT devices, remote sensing, and deployment of farm management software for the collection of real-world data.

IX. Conclusion

In this article, the common diseases that affect ginger plants have been presented. Early disease detection in ginger plants remains an important criterion for high-yield production among small- and large-scale ginger farmers. The conventional ways of preventing diseases in ginger plants have been discussed. The emergence of IoT and AI technology is providing more effective ways of preventing and detecting diseases in ginger plants. The application of AIoT can enable detection of the fungal, bacterial, viral, and nematode diseases in the soil, air, and various parts of the plant. The use of smartphones, drones, and robots in combination with AI techniques, such as HSI, XAI, and IoT, is a promising solution for future ginger farmers for successful ginger production.

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