**BTech Final Year Project 2024**

**Phase I**

**Domain**

Thermal imaging, also called as the infrared thermography, is a highly advanced technology which uses the thermal radiation emitted by objects to create an image based on the variations in the temperature . It is a non-invasive and non-destructive method which is widely scalable as it can be used in small scale and large scale and provides us with a real-time data helping in quick decision-making and timely interventions. The Integration of thermal imaging technique into the agricultural field can help us in the early detection of plant diseases causing a widespread damage, Effective water management, and Soil Moisture Assessment .

The introduction of the thermal imaging technique to the field of agriculture will lead to an increase in crop yields, and cost efficiency, Early detection of issues through thermal imaging can prevent crop failures and reduce the risk of significant financial losses. Though thermal imaging is a powerful tool, further research can improve its accuracy and reliability in detecting subtle changes in plant health or soil moisture, making it even more valuable to farmers. Combining thermal imaging with other agricultural technologies, such as drones, satellite imaging, and AI, leads to further investigation which could lead to a more sophisticated monitoring and management systems. Research into how thermal imaging can be used in different climates could play a key role in helping the farmers adapt to the unpredictable climatic changes.

Research in the field of Thermal imaging has immense potential which can transform the agricultural area. It has an undeniable relevance currently in the agricultural field as it offers a path towards more efficient, sustainable, and resilient farming practices.

**Problem**

Early detection of crop diseases is crucial for minimizing yield loss and ensuring food security. Traditional methods of disease detection often rely on visual inspection, which can be time-consuming and prone to error. Thermal imaging presents a non-invasive approach to detecting anomalies in crops, but current methods may miss early-stage diseases due to limitations in pixel analysis. Our project aims to explore the presence of mixed pixels in thermal images as a means to determine whether the infrared spectrum is plagued by the same problem that is seen in the full spectrum images. Further, we seek to address this issue and generate a viable solution to tackle the mixed pixel problem and thereby enhance the early detection of crop diseases. We will investigate whether our study can provide more accuracy as well as timely identification of diseased areas in crops.

**Dataset**

The dataset for this project will consist of thermal images captured from various crops using a high-resolution thermal camera Ti480pro. These images will be taken under controlled environmental conditions to ensure consistency. The dataset will include a variety of plants in, including healthy as well as those affected by various diseases. Each image will be labeled with metadata detailing the type of plant, the specific disease (if present), and the conditions under which the image was taken. This dataset will serve as the foundation for analyzing the effectiveness of introducing mixed pixels in detecting early signs of crop disease as well as a source of information for future studies.

**Hypothesis**

Mixed pixels would be visible in thermal images if the image of the object in question is captured under controlled environments such as having a sharp difference in temperature with the surrounding environment. Presence of mixed pixels in thermal images would steer the study to determine a better method, if possible, to address the issue and gain the exact object data needed without any of the surrounding influence. This can significantly improve the early detection of crop diseases by enhancing the contrast between healthy and diseased areas. This approach will be evaluated against traditional pixel analysis methods to determine its efficacy in early disease detection.

**Literature Review**

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| Title of the work | Journal details/product details  (Journal/ Conference format or API Reference style) | Contributions of the paper/product | Limitations |
| Scaling of Thermal Images at Different Spatial Resolution: The mixed pixel problem | Journal – Agronomy  Volume 4, Issue 3 of Agronomy | The paper focus on the mixed pixel problem, (that is a single pixel may represent multiple temperatures). From this research, we learn how to address this problem through image processing techniques. We get to find algorithms that better separate temperature readings for accurate disease detection. | As the paper deals with a broad range of thermal image application, its finding may not be fully optimized.  Trade-off between spatial resolution and data acquisition speed impact the practicality of real-time application. |
| A novel plant disease prediction model based on thermal images using modified deep convolutional neural network | Journal of Precision agriculture - Springer | This study introduces a system that use thermal images and deep learning for plant disease detection before visual symptoms appear. | This model increase computational demand which leads to the limiting of real-time application.  This study was conducted on a limited set of diseases, further validation is required for broader application |
| Early detection of plant disease using infrared thermal imaging | Optics for Natural Resources, Agriculture, and Foods (October 23,2006) | This study demonstrates how infrared thermal images can detect temperature variations in plants that indicate the stress or disease. It helps to detect disease without physical contact. | Resolution of I R imaging may not be able to detect small infections and early symptoms.  The accuracy depend on calibration and standardization which is complex and time consuming. |
| Application of thermal imaging for plant disease detection | IOP conference Series: Earth and Environmental science | This study addressed the possible use of thermal techniques for identification of plant disease. It shows that, it is possible to monitor changes in plant temperature associated with disease development allowing early detection. The successful application of the techniques discussed can detect crop disease and classify them with an accuracy more than 70%. | Challenges related to calibration of thermal imaging device and lack of standardized protocol that leads to inconsistent result.  Complexity of model affect its interpretability |
| Application of infrared thermal imaging for rapid diagnosis of crop disease | IFAC Papers Online | In this study infrared thermal imaging of tomato mosaic and wheat leaf rust was continuously detected by thermal image processing during a disease incubation period. This researched showed us that it is feasible to realize the effective determination of lesion by the IR thermal imaging combined with MTD value. | Dataset use is limited. This affect the generalizability.  As it focus on tomato mosaic and wheat leaf rust it causes a variation in detection accuracy.  Implementation in large scale require advanced techniques and expertise that could be a barrier for widespread adoption. IR imaging requires specialized equipment and expertise |

**Research**

Our study aims to establish the presence of mixed pixels in the images of the infrared spectrum as it is seen in those of the full spectrum images as well as probing into new methods of tackling it. This would have a significant impact as it lays the groundwork with which people would be made aware of its existence as well as in the method of proper extraction of the relevant information which will help in all future studies that surrounds the area of thermal imaging as more focus would be given to the original problem statement, thereby saving time and resources which would have been expended unnecessarily.

**Novelty**Though mixed pixels were discovered in thermal imaging, exact conditions for its occurrence remains a vague statement, which we hope to address through this study. At the same time, we hope to discover a more accurate way of addressing the mixed pixel problem to avoid unnecessary loss of data during segmentation. Further we aim to develop a deep learning model with the capability of early detection of plant diseases with a higher accuracy than the ones currently available.

**References**

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