1. **Detection of early decay on citrus using hyperspectral transmittance imaging technology coupled with principal component analysis and improved watershed segmentation algorithms**
   (Link: https://www.sciencedirect.com/science/article/abs/pii/S0925521419309512)

Summary
Early detection of decaying citrus fruits are essential for preserving in cold storage and ensuring sound state at the time of transportation. Spots on surface peel are created by soaking water from dead cell tissues caused by different fungus. Therefore, previously different methods were used to detect citrus fruits decaying caused by Penicillium Spp. (fungi) and defects on fruit skin such as canker spot, wind scarring etc. These methods include Machine Learning with color detection camera, RGB images, UV induced fluorescence imaging technology which only could reach up to 65% in detection accuracy rate. In this research, the contributors observed a new technology known as hyperspectral transmittance image within 325-1100 nm spectral region with watershed segmentation algorithm to differentiate between stem end tissue (used PC2 image) and decayed tissue (used PC3 image) using pseudo color image transformation and accuracy rates are 93% and 96% respectively for orange.

Methodology
In this paper, the researchers used a novel approach for detecting decayed region in orange and these methods are as follows:

- Hyperspectral transmittance image within 325-1100 nm for higher accuracy rate.
- Principle component (PC) images for decay detection
- Principle component analysis (PCA) for stem end identification
- Improved watershed segmentation algorithm

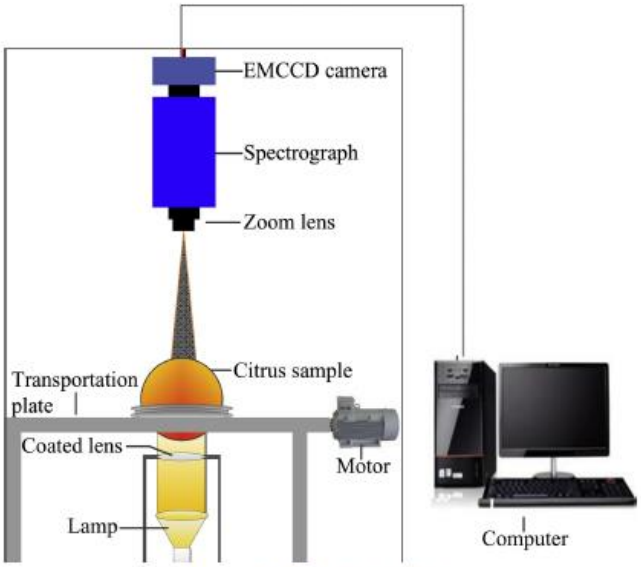

Fig. 1. Hyperspectral transmittance imaging system.

Equations

There are some equations which are used during the analysis of hyperspectral transmittance images. These are given below:

- The calibrated image T, for hyperspectral transmittance image,
  T = RawDark / WhiteDark
- Morphological geodesic dilation,

$$\begin{cases} D_b^1(\nabla f(x,y), r) = min(\nabla f(x,y) \oplus b, r) \\ D_b^{i+1}(\nabla f(x,y), r) = min(D_b^i \oplus b, r)(i = 1,2,3, \ldots) \end{cases}$$

- Morphological geodesic erosion,

$$\begin{cases} E_b^1(\nabla f(x,y), r) = max((\nabla f(x,y) \Theta b), r) \\ E_b^{i+1}(\nabla f(x,y), r) = max(E_b^i \Theta b, r)(i = 1,2,3, \ldots) \end{cases}$$

- Morphological gradient of image,

$$\nabla[f(x,y)] = (f \oplus b)(x,y) - (f \Theta b)(x,y)$$

- C= 4πA / P2

Findings

Previously using other methods could only get around 65% accurate decay detection, but combining hyperspectral transmittance image with image processing provides 93% and 96% accuracy rate for stem end identification and decay detection in citrus fruit respectively.

Novelty

- The novelty of this paper is using hyperspectral transmittance image, improved watershed segmentation algorithm and pseudo color image transformation at the same time.
- The researchers also found out the difference between stem end image and decay detection image of citrus fruits like oranges so that the accuracy rate of decay detection increased more than previous findings.
- Also they used PC2 image for stem end detection, PC3 image for decay detection, R component, G component,B component for better observation in image processing.

Algorithm Used
They have used here improved watershed segmentation algorithm, stem end identification algorithm,

Analysis
In this paper, they have analyzed PC2 image, Pseudo color image, R component, G component, B component images for better identification of decayed region and stem end region.

Problems Faced
While writing these segments, I have to search about IWSA, PC2,PC3 and hyperspectral transmittance images for better observation.

Future Work
Usage of image processing along with the collaboration of hyperspectral transmittance image can give us relatively accurate decay detection information which is not that much familiar in our research areas.

Research Gap
Although they have mainly used hyperspectral transmittance image and pseudo color image transformation technology, they haven't recognized these as a part of image processing.