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# Hyperspectral Imaging - An innovation in Agriculture Sector

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***Abstract:***
*Hyperspectral imaging is an emerging technique in the agriculture sector to obtain spectral and spatial data of plant without destruction of plant parts. Traditional sampling ways are a destructive method that damages the plant parts and required more time. This is the best method to get results from a large area within minimum time. We can obtain our research goals without physically effecting the plant parts. Nowadays, its application includes mapping of vegetation, crop diseases and pest attack, crop stress and yield analysis, plant parts identification, nutrients measurements and exposure of impurities. Agriculture elements consist of different chemical and physical compositions, in the response with near-infrared spectroscopy, plant parts will reflect, absorb, scatter or emit waves in different ways at a specific wavelength. These variations are characterizing with spectral signs of that part. The purpose of literature is to provide basic information about the role of hyperspectral imaging and its application in the agriculture sector.*

***Keywords****: Hyperspectral Imaging - HIS Wavelength & Spectral -Application in Agriculture*

## 1. Introduction:

Hyperspectral, the word "hyper" mean "too many" that refers to a huge amount of obtained wavelength band. Human eye based on the main three colors (red, green, blue) band but hyperspectral images can divide into many bands. We get hundreds of images of bands data by remote sensors. These images are analyzed with laboratory or reflectance spectrums to get information about research like a map of surface materials. Image spectrometers are used to develop the hyperspectral images. The remote sensors images and spectroscopy are the two important innovation applied to develop hyperspectral sensors. Spectroscopy defines the light emission or reflection from different parts of material and varies occurred in energy with wavelength. Previously Near-infrared spectroscopy was used that just gives one spectrum/ measurement but new technology hyperspectral provides thousands of spectra/ measurements. In, the recent year both near-infrared spectroscopy and hyperspectral (HIS) are combined in a single step called NIR-HIS. The picture taken by a combination of these gives a spectral signature of the material that is particular and can be used to classification and classify the material (1). In previous years, hyperspectral images used for the application of remote sensing due to the reflection properties of spectra. It was used to detect the army vehicles that are hidden in vegetation (2). The hyperspectral image can be used for mapping and study the soil surface and soil properties, soil moisture level, organic matter and soil salinity (3-4). Its techniques also used paper industry (cardboard, newspaper, pulp, etc.) medical sector to identify the different diseases like peripheral vascular disease and in oncology immunohistochemistry, face detection in biomedicine and cancer diagnosis (5-8). The spectral images are divided into three forms: multispectral imaging, Hyperspectral imaging and ultraspectral imaging (USI). These are further classified on the basis of wavelength

## 2. Application of NIR-HIS Systems in Agriculture Sector

NIR-HIS system is divided into different systems that varies with satellite images for different purposes: (a) Satellite HIS System (b) Airborne VIS/NIR System (c) Ground based Hand HIS system (d) Laboratory -Scale HIS System. Satellite HIS System is also used in agriculture sector like determining the physical properties of plant like leaf size, leaf area index, leaf pigment concentration monitoring plant growth, plant stress, fertilizers, and irrigation application systems. (9-12).

A hyperspectral camera embedded on OnyxStar HYDRA-12 UAV from AltiGator

Airborne satellite data used in canopy studies like plant disease attack, plant yield, and leaf area index. Ground-based HIS System images used to estimate the field production; normally camera fixed on agriculture vehicle for data collection. Yang et al. used this system to estimate the sorghum grain yield using a CCD camera-based HIS system (13). This system gives suitable results to measure large fields. Laboratory- Scale HIS System is a qualitative application to measure the meat and bone meal in compound feedstuff (14). NIR-HIS is also used to determine the quality of food especially fruits quality because it is important for consumers acceptance, its shelf life and most important is a nondestructive method. HSI System is also used in food and water bacterial contamination measurements (15). HSI Application increases the efficiency of irrigation, nutrients, and yield with minimizing labor cost. HIS images allow us disease identification, weeds location, production information with reference to the current scenario of the crop, crop maturity stages and seed viability which are important aspects to increase production. Application of HIS imaging is a wide and useful technique used by many scientists (Thenjabail et al., 2000; Apan et al., 2004; Jay et al., 2010; Yang et al., 2014; Nansen et al, 2015; Senthilnath et al, 2016), making it a useful method in agriculture sector (15). The condition in which there is no contact between sensor and object is referred to as remote sensing. Evaluation and measurements of biochemical and biophysical aspects of the crop are important for increasing crop production as well as measurements of water stress pigment, moisture level, and nutrition availability. This data can be obtained directly from the field, but it is more time and laborious. But, using remote sensing can overcome these two aspects because it requires less time and provides more accurate data. Satellites or airborne remote sensing is applied for such type of research work. Lamb and Brown (2001) applied airborne remote sensing method to explore the presence of the weed in the crop. He observed two important aspects. (a) clear differentiation between weeds and their background plant canopy, and (b) it provides spatial and spectral resolution for detection of weeds presence. Application of remote sensing in Agriculture also applied to monitor the plant stress due to weeds infestation, pest and disease attack, water, changing of soil temperature measured by Hatfield and Pinter in 1993. Moran et al. (1997) reviewed the limitation of HIS Application for measurements of soil moisture level, crop phonologic stages, nutrition deficiencies, plant disease, weeds attack, and insect attack. Early Identification and detection of diseases and pest attack are important to minimize the yield loss due to these threats. A farmer can manage these threats properly on time to get maximum yield. These are the two major problems in yield reducing overall the world. Remote sensing has the ability to identify the different species of plants and weeds identification in agriculture crops. Identification of dangerous species is important

for the ecosystem and other plant species (16-17). For example, Tamarix (Salt cedar) is the one of the famous threating species in the United States of America due to its salt contents increasing property in soil by absorbing water from different sources. The estimation of yield is the important in agriculture management. The Application of remote sensing, GPS receivers and GIS play an important role to estimate the yield, better land management and help in farming techniques (18). Crop productivity relate to soil electrical conductivity, that determines soil salinity and its properties.23 Soil nutrition level, Nitrogen contents, soil properties, insect pest, and disease, are the key parameters that directly effect yield. The overall yield of a field can be estimated by making a crop yield estimation model by using data such as weather data, soil characteristics, disease, pest attack, and crop type. The different application has different sensors and spectral range that depends on the purpose of application; some of them are described in the given table.

| **Application characteristics of Hyperspectral Imaging Systems in Agriculture** | | |
|---|---|---|
| **Detector** | **Spectral Range** | **Application** |
| CCD | 400-1000 | detecting bruises on apple |
| MCT | 900-1700 | detecting aflatoxin on corn kernels |
| CCD | 398-1010 nm | detecting blueberry fruit maturity |
| CCD | 550-800 nm | fungal diseases |
| CCD | 400-720 nm | detecting external insect infestations |
| CCD | 385-1000 nm | |
| CCD | 650-1100 nm | measuring soluble solids |
| CCD | 400-1000 nm | bruise damage detection |
| CCD | 400-1000 nm | quality attributes for strawberry |
| CCD | 600-1000 nm | detection of apple fruit |
| CCD | 400-1000 nm | Evaluation of the shelf-life of mushrooms |
| CCD | 400-1000 nm | defect and surface color of whole pickles |
| CCD | 430-900 nm | poultry inspection |
| CCD | 500-1000 nm | peach fruit firmness |
| CCD | 400-1000 nm | wheat and weed discrimination |

Table.1 Ahmed, et al., (2016) Described Application classification of detectors and spatial range (16)

Mapping of vegetation area of any region is time consuming and laborious with traditional methods; however, with HIS classification of different vegetation is easy and more accurate. The literature showed that vegetation classification of an area is more accurate with narrowband as compared to multispectral data. To get the changing data of a field, data collect before seeding, during planting, and after harvesting. During the mid-season, crop monitoring gives results of different plant species, pest and disease attack which help to finalize application decision. Although the hyperspectral imaging is much cost methods as compared to other methods, it gives accurate and fast results. Australia is using imaging spectrometers to identify the grape varieties and early detections of diseases attack (19). Hyperspectral data is also using to identify the composition of chemicals in plant parts that are beneficial for nutrients and water requirement status in wheat (20). Its applications are also used to detect the Mad-cow disease (bovine spongiform encephalopathy (BSE) in animal feeds proteins.

## Conclusion:

Hyperspectral Imaging Technique is an emerging technique in the agriculture sector. The monitoring of plant stress situation, nutrients status, detection of disease, fruit maturity, and weeds infestation are important aspects for better yield. HIS helps to determine these aspects in a better way to get high efficiency in the agriculture sector. This is a costly system as compared to other methods, but it saves time and gives more accurate results.

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