Comparing Hyperspectral and Multispectral satellite imaging for within-field maize yield prediction using Support Vector Machine and ANN

Ojenge Winston
Strathmore University
E-mail: wojenge@strathmore.edu

Maize Yield Prediction

1. Weather and soil conditions Vs Yield
2. Crop Appearance Vs Yield

Techniques for building prediction model;

a) Mental prediction
b) Mechanistic prediction
c) Statistical prediction
d) Machine Learning

V Healthy | Healthy | Average | Poor | V Poor

Methods of Data Collection

1. Casual
2. Visible cameras
3. Chlorophyll Spectrometers

4. **Radiometers**

a) Multispectral Imagers
b) Hyperspectral Imagers

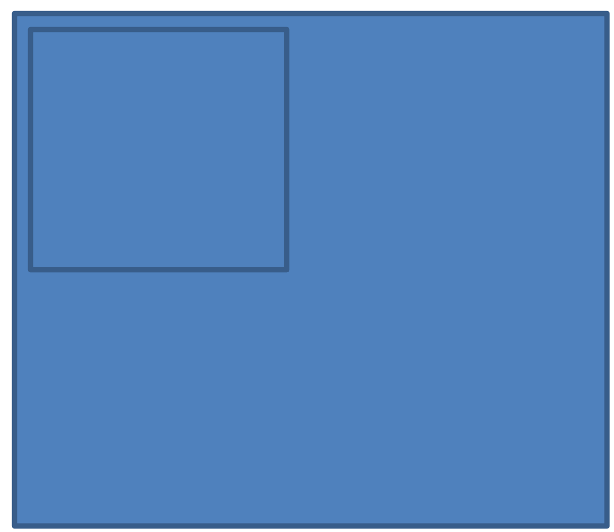
Multispectral / Hyperspectral Imaging

<u>Pixel</u>

- Picture cell
- Unit of image analysis
- Size of pixel on the ground depends on spatial resolution of camera

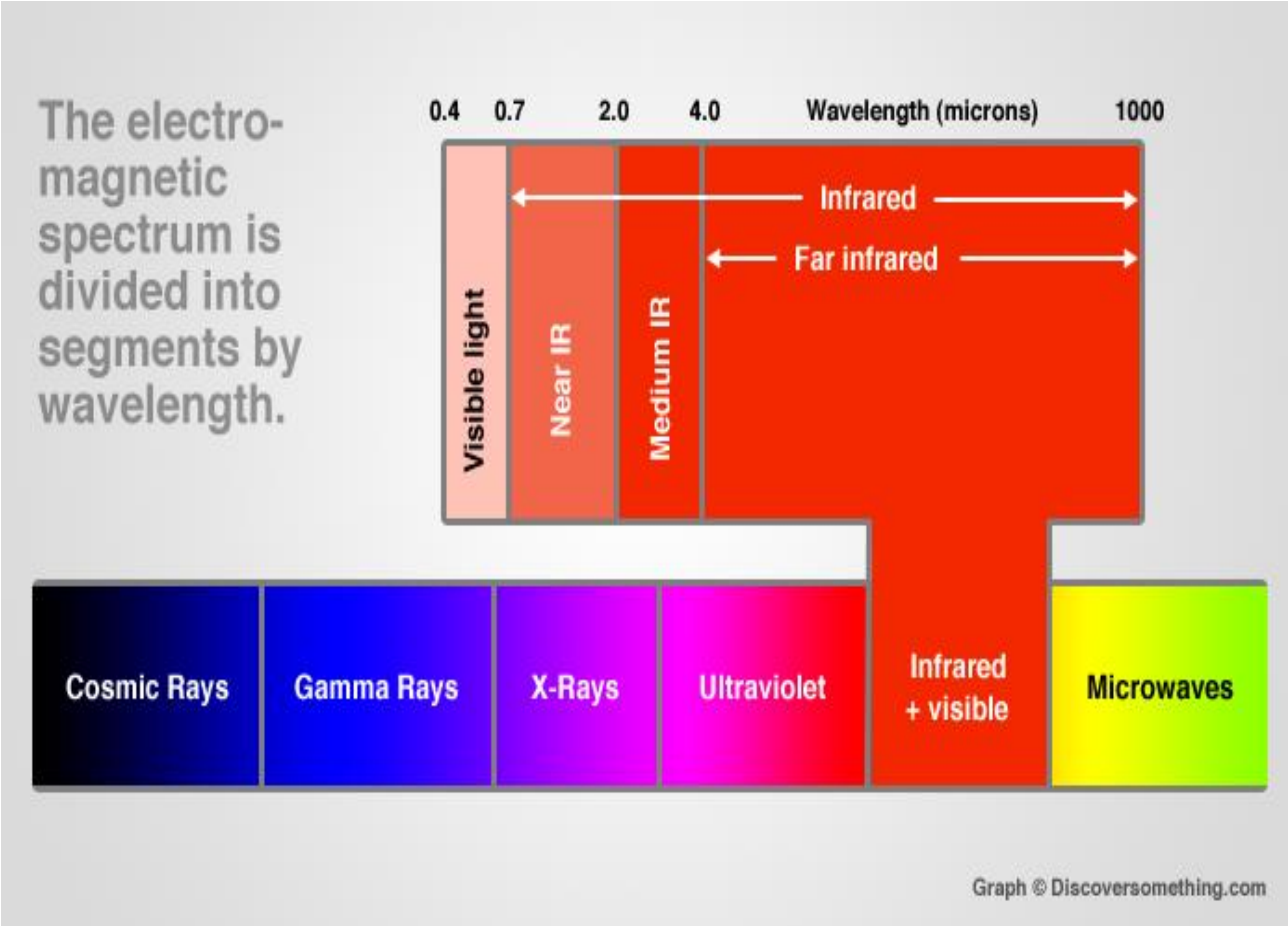
Different Spatial Resolutions

- Each of the shown land plots is, say, 120m by 120m.
- In first case, spatial resolution is 2m while in second case, spatial resolution is 30m



Multispectral / Hyperspectral Imaging

- Each pixel is analyzed for light intensity (leaf reflectance) across a range on the electromagnetic spectrum as follows;



The electro-magnetic spectrum is divided into segments by wavelength.
0.4
0.7
2.0
4.0
Wavelength (microns)
1000
Infrared
Far infrared
Visible light
Near IR
Medium IR
Cosmic Rays
Gamma Rays
X-Rays
Ultraviolet
Infrared + visible
Microwaves
Graph © Discoversomething.com

Multispectral vs Hyperspectral Imaging

1. **Multspectral** – within the relevant range, has few, wide bands, where each band is analyzed for amount of reflectance received by the imager
2. **Hyperspectral** – has much narrower bands which are, therefore, many. Massive data of each pixel is obtained

Platforms

1. **Satellite platform**

- Total coverage
- Purchase of images cheap (Scene: $600)
- But resolution poor
- To get enough pixels per scene, scene must be wide area

But Africa grows its grain in small holdings (1-4 acres)

- Each proprietal plot, likely, has different farming management and varying yields/ acre
- Analysis of crop must be done within proprietal plots
- Imaging must be detailed enough to obtain enough pixel count for 1-4 acres

Platforms

2. Aerial Platform

- Imaging of choice for within-field analysis of crop (closer to earth for good detail: high resolution)
- But too costly for Africa (Kenya)
- Importing imager and hiring aircraft may be over Ksh 2m

Problem Statement

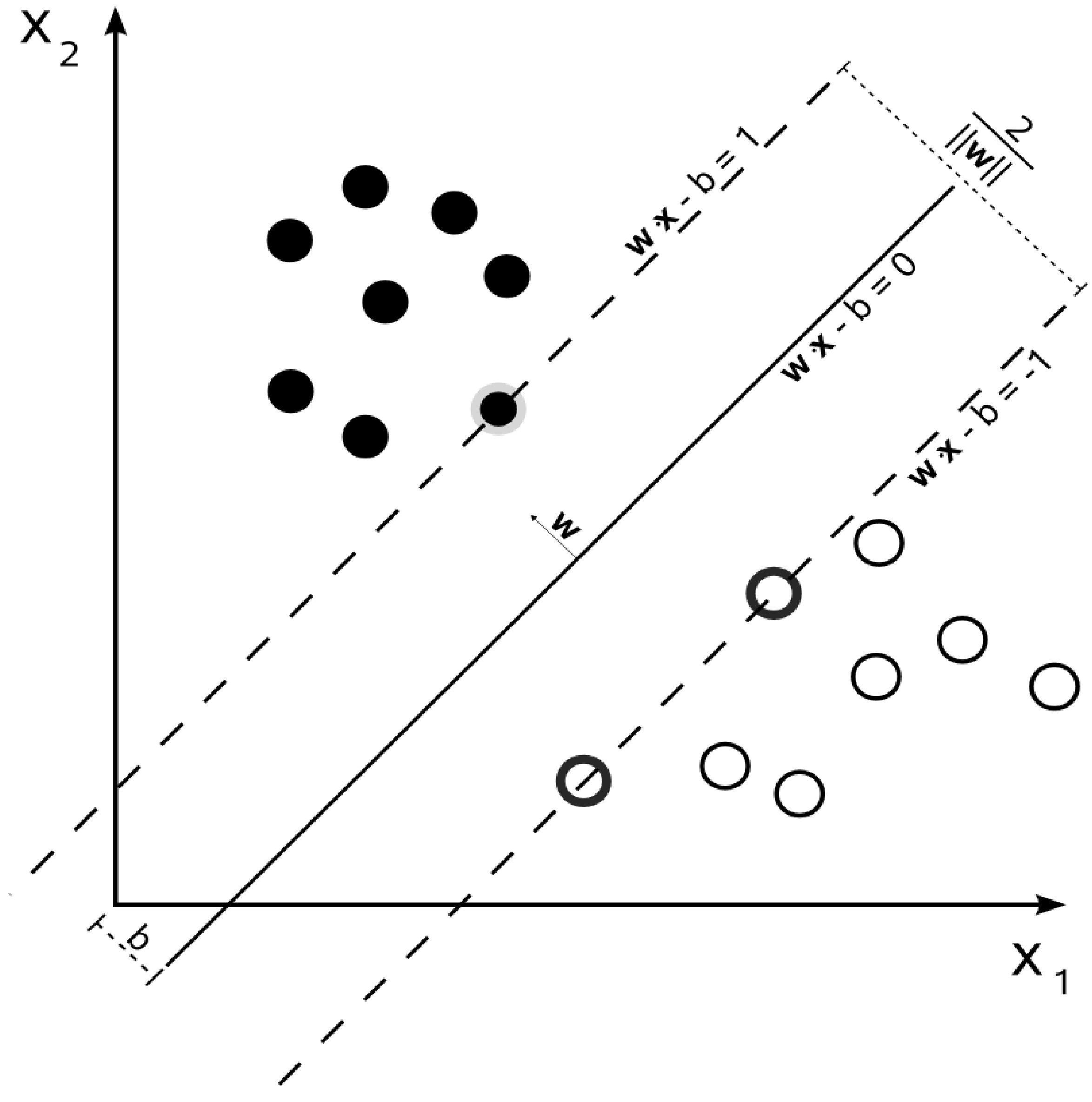
- In Africa (Kenya), there is need for a cost-effective imaging platform but with detail enough to collect spectral data of crop in a small holding of 1 to 4 acres to enable analysis of each plot for building of a yield.

Hypothesis

- To reasonably identify a spectral object, 5 to 6 pixels of it is required.
- Study assumes that 3 acres (120m by 120m) is reasonably representative of a Kenyan farmer's plot.

1. **Hyperspectral** – Hyperion imager on E01 (resolution of 30m) = 16 pixels
2. **Multispectral** – Imager on QuickBird (resolution of 2.4m) = 2500 pixels
3. **SVM / ANN** for data analysis and construction of model

SVM (Maximum Margin Classifier) vs ANN and other ML techniques



Methodology

- 5 (V Healthy, Healthy, Average, Poor, V Poor) plots by 4 = 20 plots of 120m by 120m each
- SERVIR as image data source during tasseling
- Use ENVI and WEKA for analysis
- Construct model