# YEESI 104 : Machine Vision in Agriculture

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# Introduction

The course develops an understanding of how robots and computers "sense" and "recognize" the surrounding agricultural environment
**Course Objectives:** At the end of the course candidates should be able to: -

- Demonstrate arithmetical, logical, and other operations on images
- Develop systems that can recognize objects
- Demonstrate an understanding of the basics of visual learning and neural networks for the purpose of classification
- Perform computer vision tasks such as image processing and manipulation using OpenCV and Raspberry Pi

# Course Contents

The following will be covered in this course:

1. Basics of Image Processing
2. Object Recognition and Convolutional Neural Network
3. Number Plate Recognition with Deep Convolutional Networks,
4. Face Detection and Recognition with the DNN Module

# Machine Vision

## What is Machine Vision?

Machine Vision (MV) includes all technology and methods used to extract information from an image on an automated basis.

A machine vision system uses a camera to view an image, computer vision algorithms then process and interpret the image, before instructing other components in the system to act upon that data

# Applications of Machine Vision in Agriculture

- **Field Robots:** To automate processes such as harvesting, planting, weeding, machine vision systems are used to identify and categorize crops, providing essential visual input for all of the tasks listed above.Eg. Cotton Picking Robot
- **Counting, Grading and Sorting:** When combined with deep learning techniques, machine vision can sort good crops from bad crops and determine which will be stable for longer shipments and which will go bad first and should be shipped to local markets.See Counting of Fruits using Machine Vision

# Cont..

- **Livestock Identification:** Machine vision can be used to identify livestock and monitor their growth over the course of their lifetime to provide important information about their progress towards harvesting.Example: MV Cattle Identification
- Machine Guidance: Machine vision is used to guide autonomous tractors and other vehicles in variable outdoor conditions for full autonomy.
- Phenotyping: Machine vision helps to identify the best breeds by monitoring growth and identifying phenotypic traits that signify a robust genotype

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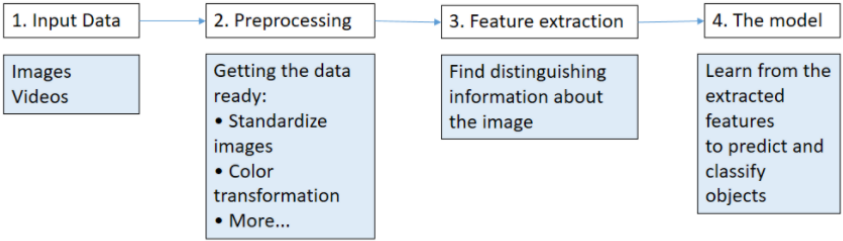
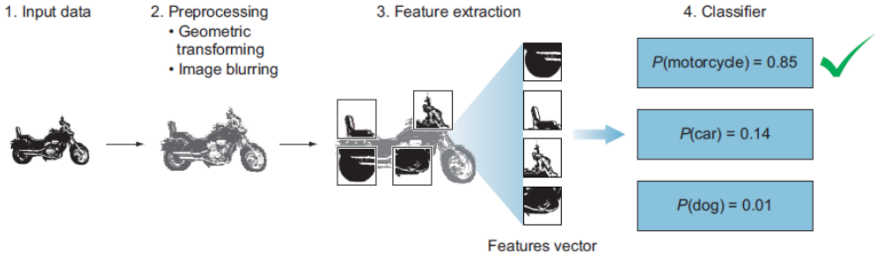
# The Pipeline

- Applications of machine vision vary, but a typical vision system uses a sequence of distinct steps to process and analyze image data.
- Many vision applications follow the flow of acquiring images and data, processing that data, performing some analysis and recognition steps, and then finally making a prediction based on the extracted information.

# The Pipeline



# Example




**Source:** (Elgendy, M. (2020). Deep learning for vision systems. Simon and Schuster.)

# Question

**CAN MACHINE VISION SYSTEMS ACHIEVE BETTER PERFORMANCE THAN THE HUMAN BRAIN?**

# PART 1: INPUT DATA

# Input Data

- In MV applications, we deal with images or video data.
- An Image is simply a matrix of pixels and each pixel is the single, square-shaped point of colored light.
- A digital image can be represented by a two-dimensional array of numbers( pixels) ranging between 0 and 255.
- It is defined by the mathematical function f(x,y) where x and y are the two co-ordinates horizontally and vertically.
- The value of f(x,y) at any point gives the pixel value at that point of an image.
- The pixel values represent the intensity of light that appears in a given place in the image.

# How computers see images

A 2D matrix of the pixels' values, which represent intensities across the color spectrum.

What we see

What computers see

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 08 | 02 | 22 | 97 | 38 | 15 | 00 | 40 | 00 | 75 | 04 | 05 | 07 | 78 | 52 | 12 | 50 | 77 | 91 | 08 |
| 49 | 49 | 99 | 40 | 17 | 81 | 18 | 57 | 60 | 87 | 17 | 40 | 98 | 43 | 69 | 46 | 04 | 56 | 62 | 00 |
| 81 | 49 | 31 | 73 | 55 | 79 | 14 | 29 | 93 | 71 | 40 | 67 | 53 | 99 | 30 | 03 | 49 | 13 | 36 | 65 |
| 52 | 90 | 95 | 23 | 04 | 60 | 11 | 42 | 69 | 24 | 48 | 56 | 01 | 32 | 54 | 71 | 37 | 02 | 34 | 91 |
| 22 | 31 | 14 | 71 | 51 | 67 | 43 | 59 | 41 | 92 | 34 | 54 | 22 | 40 | 40 | 28 | 44 | 33 | 13 | 80 |
| 24 | 47 | 32 | 60 | 99 | 03 | 45 | 02 | 44 | 75 | 33 | 53 | 78 | 36 | 64 | 20 | 35 | 09 | 12 | 80 |
| 32 | 98 | 81 | 28 | 64 | 23 | 67 | 10 | 26 | 38 | 40 | 67 | 59 | 54 | 70 | 66 | 18 | 38 | 64 | 70 |
| 47 | 24 | 20 | 68 | 02 | 62 | 12 | 20 | 95 | 63 | 94 | 39 | 63 | 04 | 49 | 91 | 44 | 49 | 94 | 21 |
| 24 | 55 | 58 | 05 | 66 | 73 | 99 | 26 | 97 | 17 | 78 | 78 | 94 | 83 | 14 | 88 | 34 | 89 | 63 | 72 |
| 21 | 36 | 23 | 09 | 75 | 00 | 74 | 44 | 20 | 45 | 35 | 14 | 00 | 41 | 33 | 97 | 34 | 31 | 33 | 95 |
| 78 | 17 | 53 | 28 | 22 | 75 | 31 | 67 | 15 | 94 | 03 | 80 | 04 | 42 | 16 | 14 | 09 | 53 | 56 | 92 |
| 16 | 39 | 05 | 42 | 96 | 35 | 31 | 47 | 55 | 58 | 88 | 24 | 00 | 17 | 54 | 24 | 34 | 29 | 85 | 57 |
| 84 | 56 | 00 | 48 | 35 | 71 | 89 | 07 | 05 | 44 | 44 | 37 | 44 | 40 | 21 | 58 | 51 | 54 | 17 | 58 |
| 19 | 80 | 61 | 68 | 05 | 94 | 47 | 49 | 28 | 73 | 92 | 13 | 86 | 52 | 17 | 77 | 04 | 09 | 55 | 40 |
| 04 | 52 | 08 | 83 | 97 | 35 | 99 | 14 | 07 | 97 | 57 | 32 | 16 | 26 | 26 | 79 | 33 | 27 | 98 | 44 |
| 04 | 36 | 68 | 81 | 57 | 62 | 20 | 72 | 03 | 16 | 33 | 67 | 46 | 55 | 12 | 32 | 43 | 93 | 53 | 69 |
| 04 | 42 | 14 | 73 | 38 | 25 | 39 | 11 | 24 | 94 | 72 | 18 | 06 | 46 | 29 | 32 | 40 | 62 | 74 | 36 |
| 20 | 49 | 34 | 41 | 72 | 30 | 23 | 88 | 34 | 62 | 99 | 69 | 82 | 47 | 59 | 85 | 74 | 04 | 34 | 24 |
| 20 | 23 | 35 | 29 | 78 | 31 | 90 | 01 | 74 | 31 | 49 | 71 | 48 | 86 | 81 | 16 | 23 | 57 | 05 | 54 |
| 01 | 70 | 54 | 71 | 83 | 51 | 54 | 49 | 16 | 92 | 33 | 48 | 61 | 43 | 51 | 01 | 89 | 19 | 67 | 48 |

# Classes of Digital Images

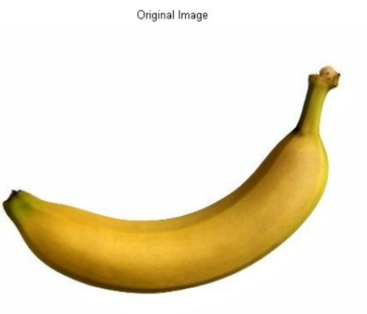
- A color image includes the color information for each pixel.
- Grayscale images consist of shades of grey as their only color

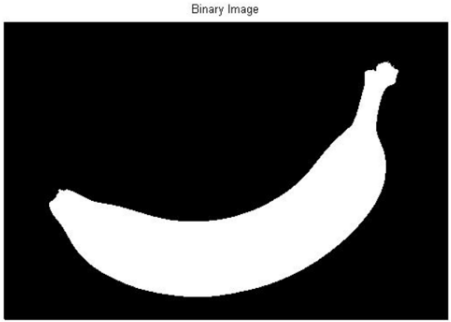
Color Image

Grayscale Image

# Classes of Digital Images

- Binary images have exactly two colors, mostly black and white pixels.



# Classes of Digital Images

- Multispectral images capture image data ranging across the electromagnetic spectrum within some specific wavelength.