

# Lecture 03

# Robot Perception

**Week 02**

**Wednesday, 1400-1550, Room 235, New Engineering Building**

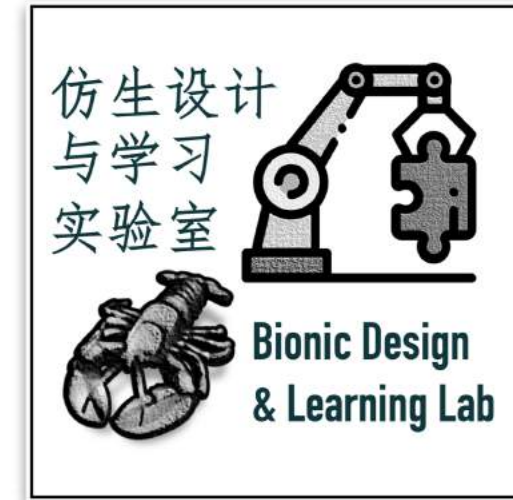
**Song Chaoyang | Asst. Prof. | Department of Mechanical & Energy Engineering | SUSTech | [songcy@sustech.edu.cn](mailto:songcy@sustech.edu.cn)**

# Agenda

**Week 02, Wednesday January 20, 2021**



- Introduction to Robot Perception
- Sense-Plan-Act
  
- Guest Lecture by He Weipeng from ByteDance



# What is Robot Perception?

**Making sense of the unstructured, real, physical world**

# Differentiate Robots and Mechanisms

**The ability to adapt to changes of their subjects of operation or of their operating environment**

- To understand the surrounding environment
- To derive a set of actions from a high level goal
- To implement (actuate and control) these actions

# Robot Perception

Physically implemented by sensors and by dedicated processing of the data they produce

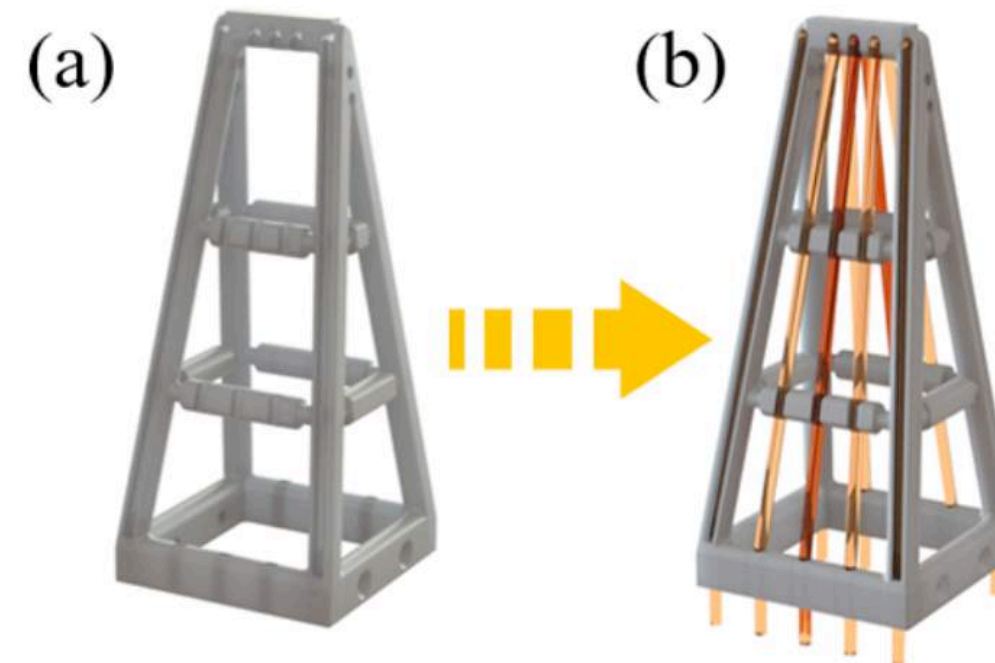
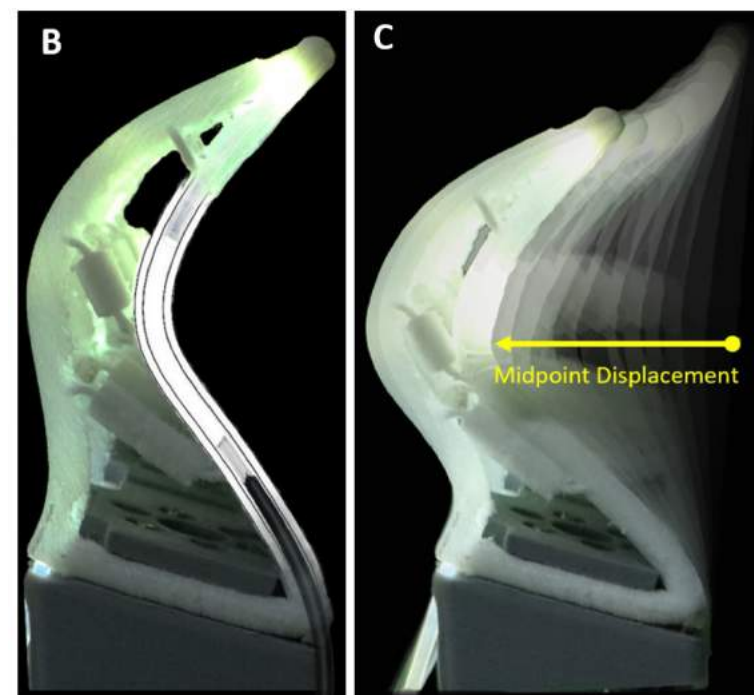
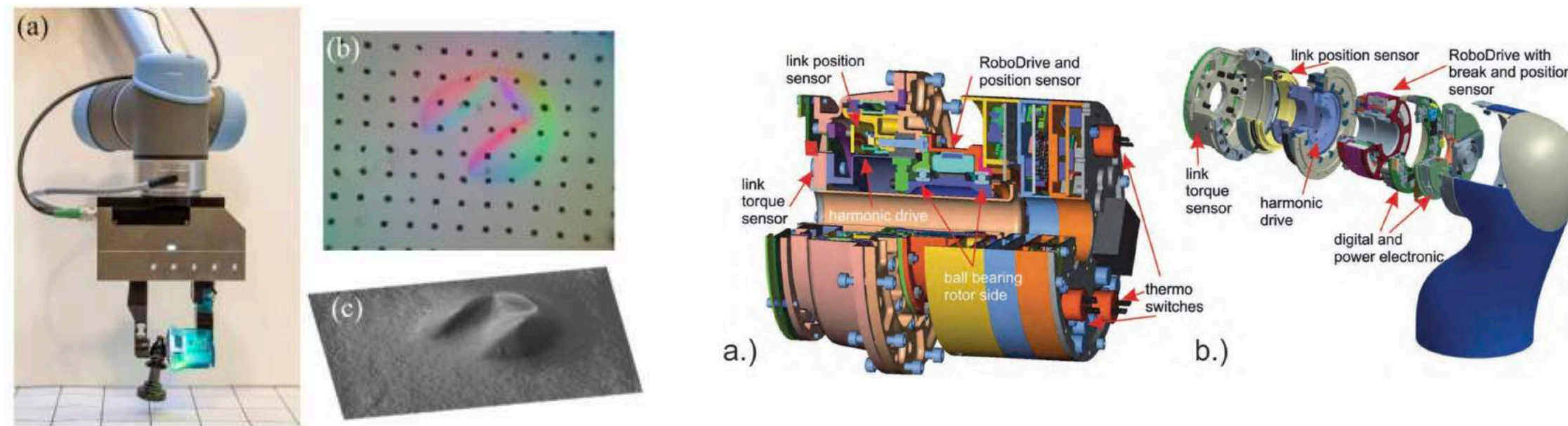
- To understand the surrounding environment
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# Enteroreceptive Sensors

**Sense things inside the robot (e.g. joint angle, speed, torque)**

- Used by the robot control systems to receive feedback on the execution of motion and in general on the status of the robot.



## MEET THE e-Series FAMILY

World's #1 Collaborative Robot.

Repeatability of 30 micron with UR3e and UR5e, 50 micron with UR10e

Built-in Force/Torque sensor

17 safety functions, all certified by TÜV NORD and compliant with latest ISO safety standards

Easily replaceable joints



Intuitive Programming Flow

Light and responsive teach pendant  
Thin cable and wide screen

Customizable stopping time and stopping distance



# Exteroreceptive Sensors

**Sense things outside the robot (e.g. proximity, vision)**

- Provide the robot control system information:
  - about the environment around the robot (e.g. rover Cameras provide images of the terrain around the rover) and
  - about the effect of robot actions on the environment (e.g. the distance between a robot hand and the object it grasps)

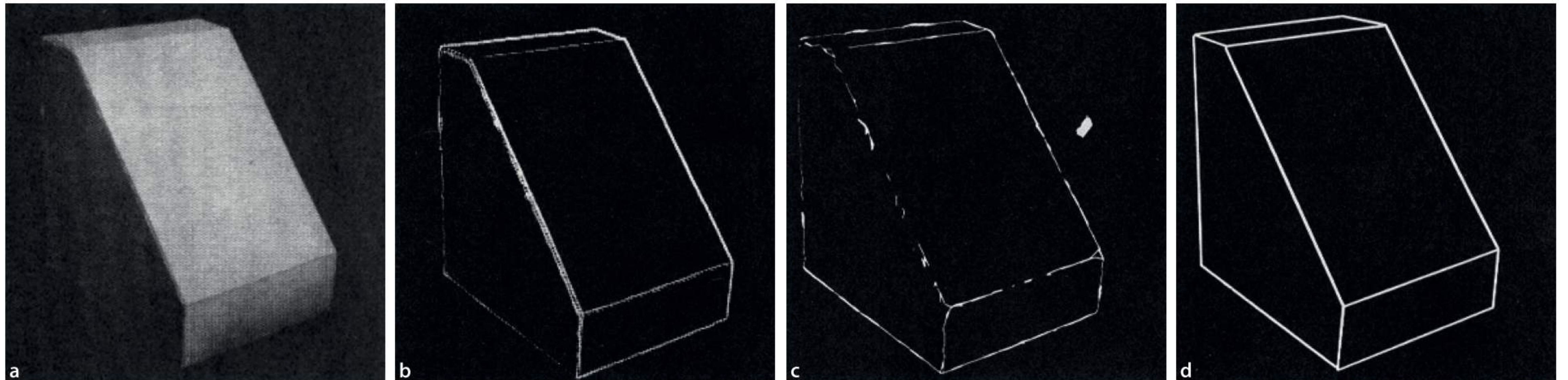




# Vision: From Animals, to Computers, then Robots

## Translating Unstructured World into Structured Data

- Early results in computer vision for estimating the shape and pose of objects



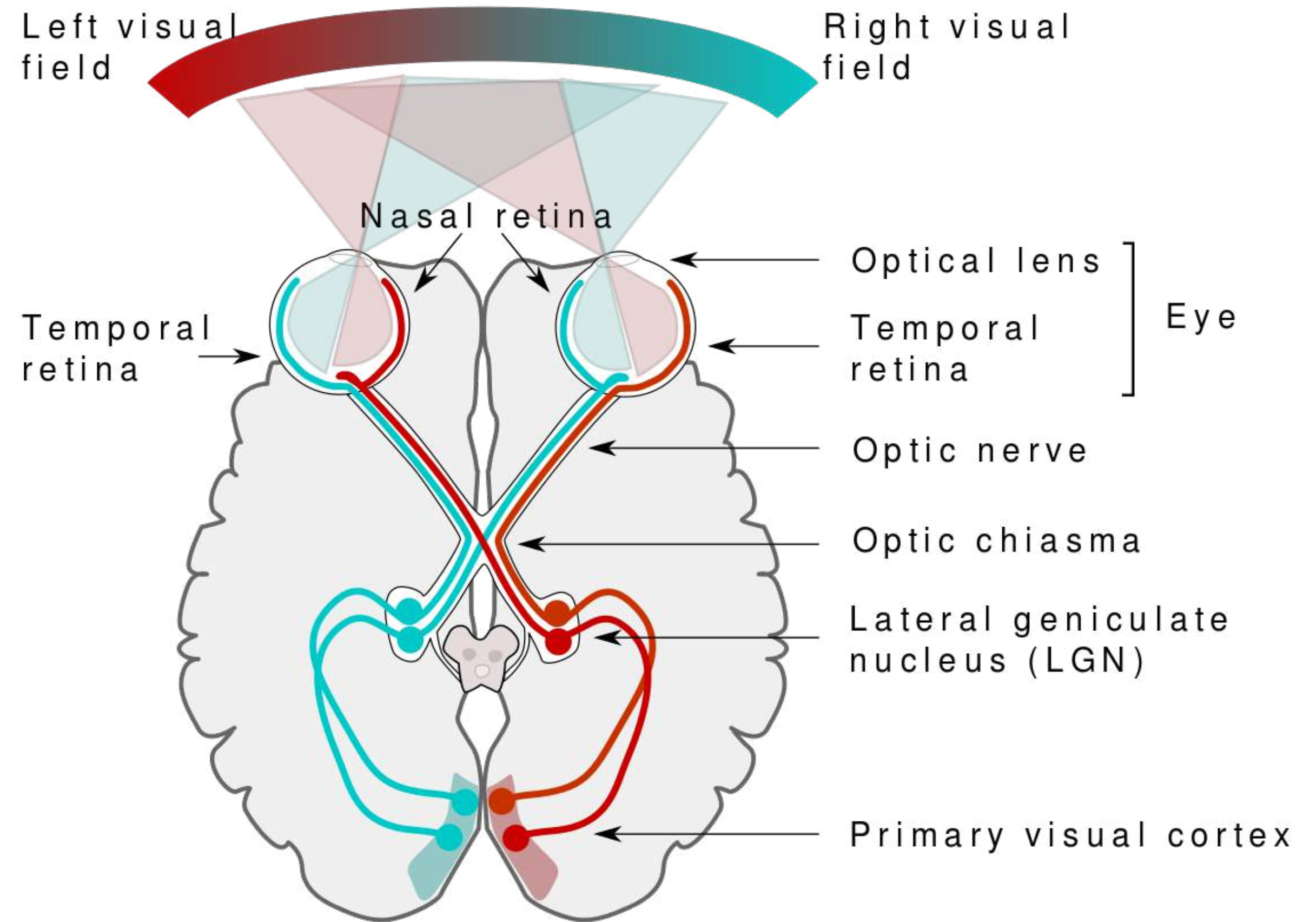
From the PhD work of L. G. Roberts at MIT Lincoln



# What is Vision?

## Vision System

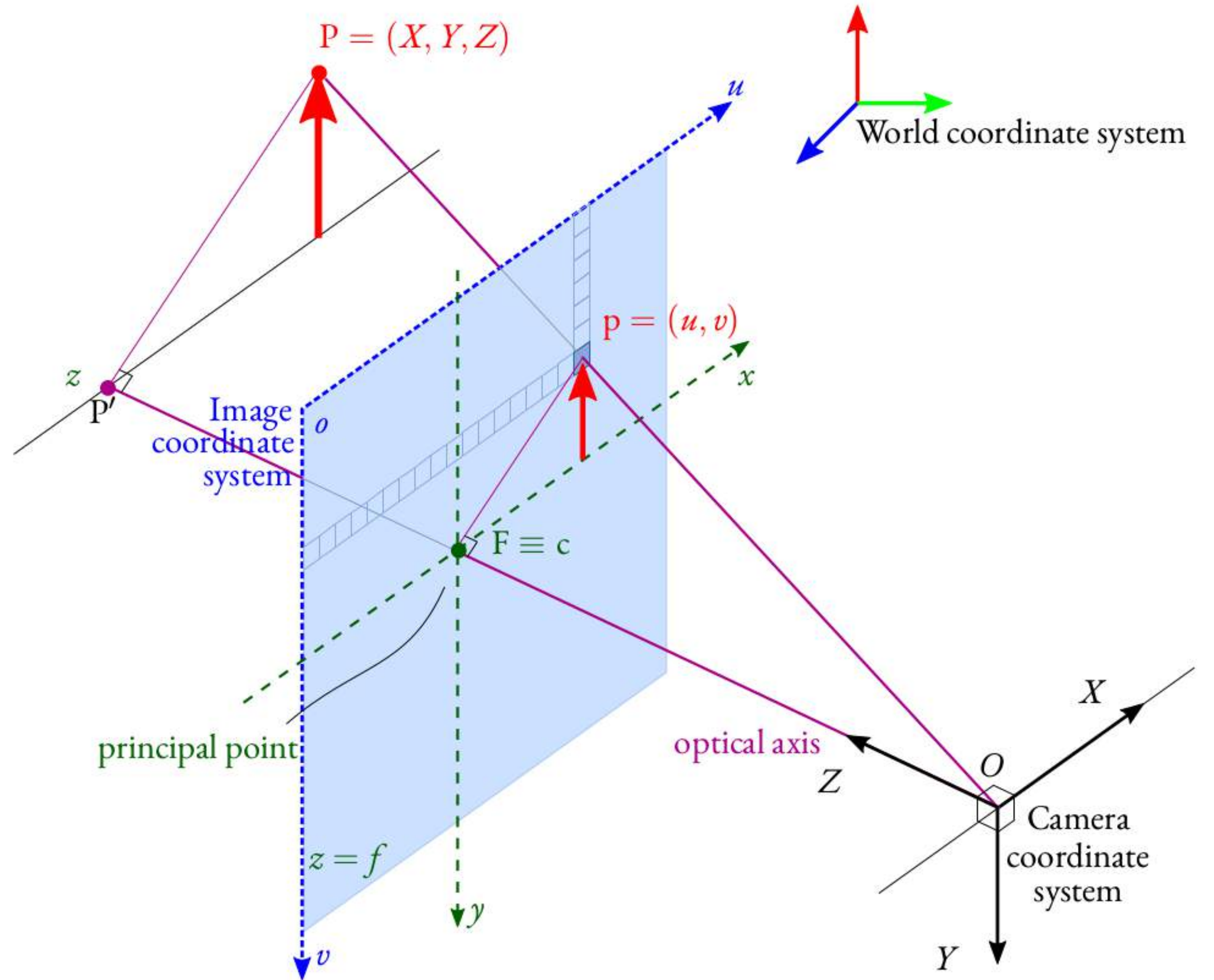
- Visual perception is the act of observing patterns and objects through sight
- Visual systems allow us to build a model of the physical world.



# What is Vision?

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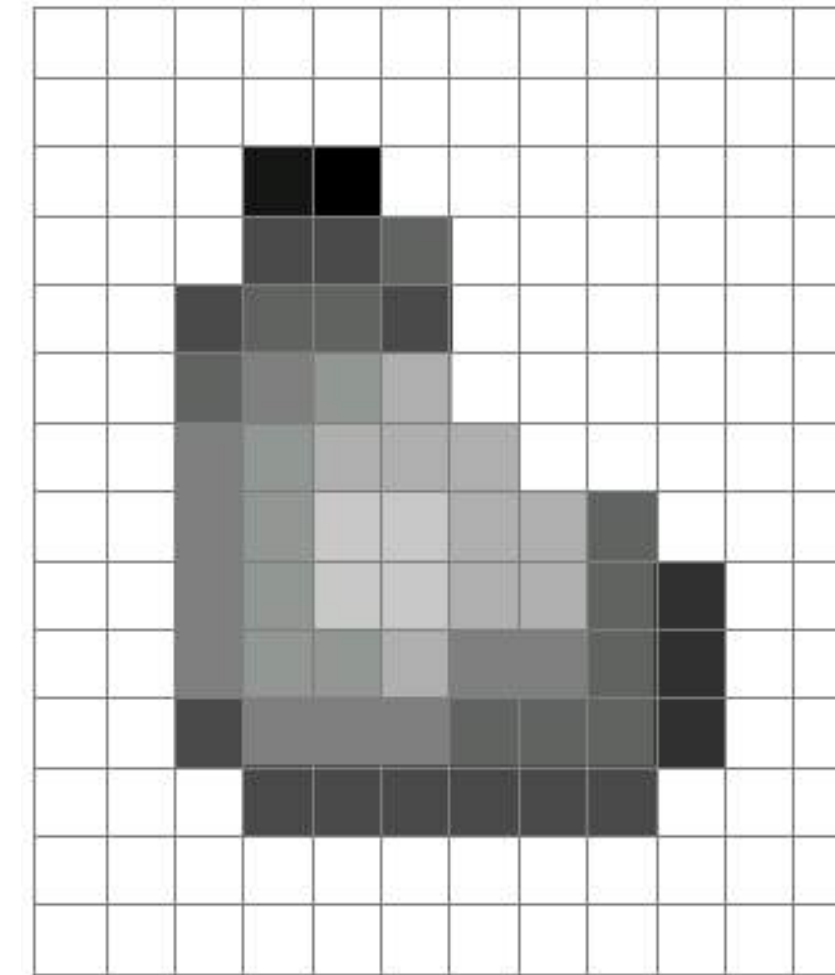
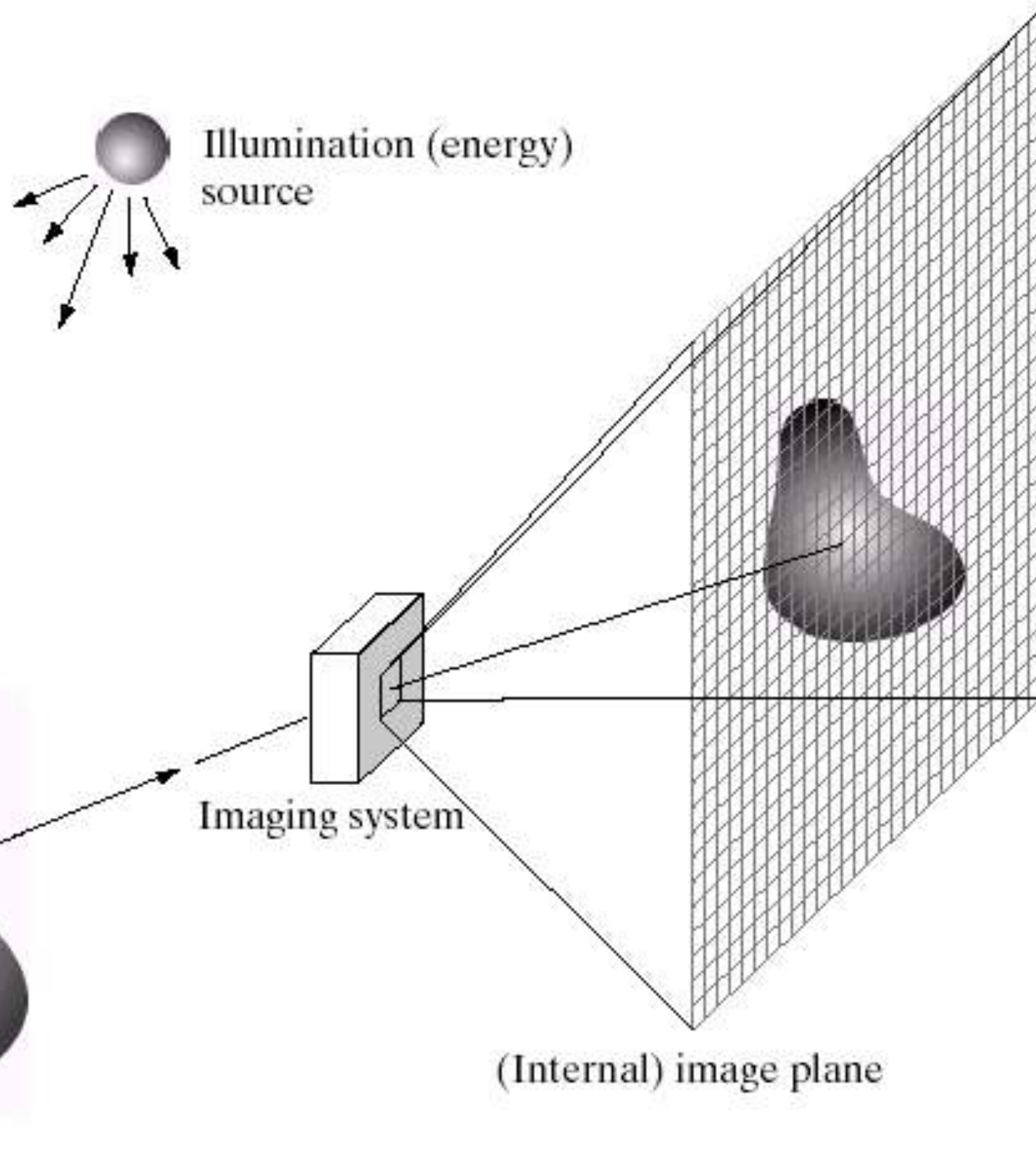




# Formulation of An Image

## As a 2D sampling of signal

**Signal:** function depending on some variable with physical meaning.

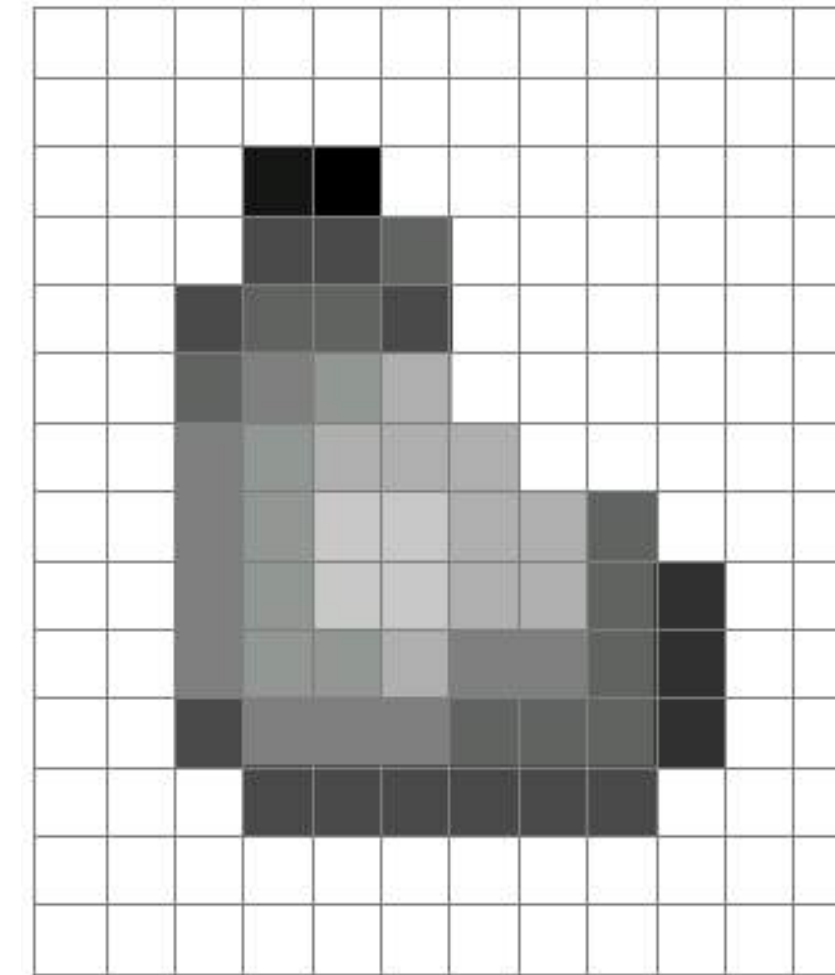
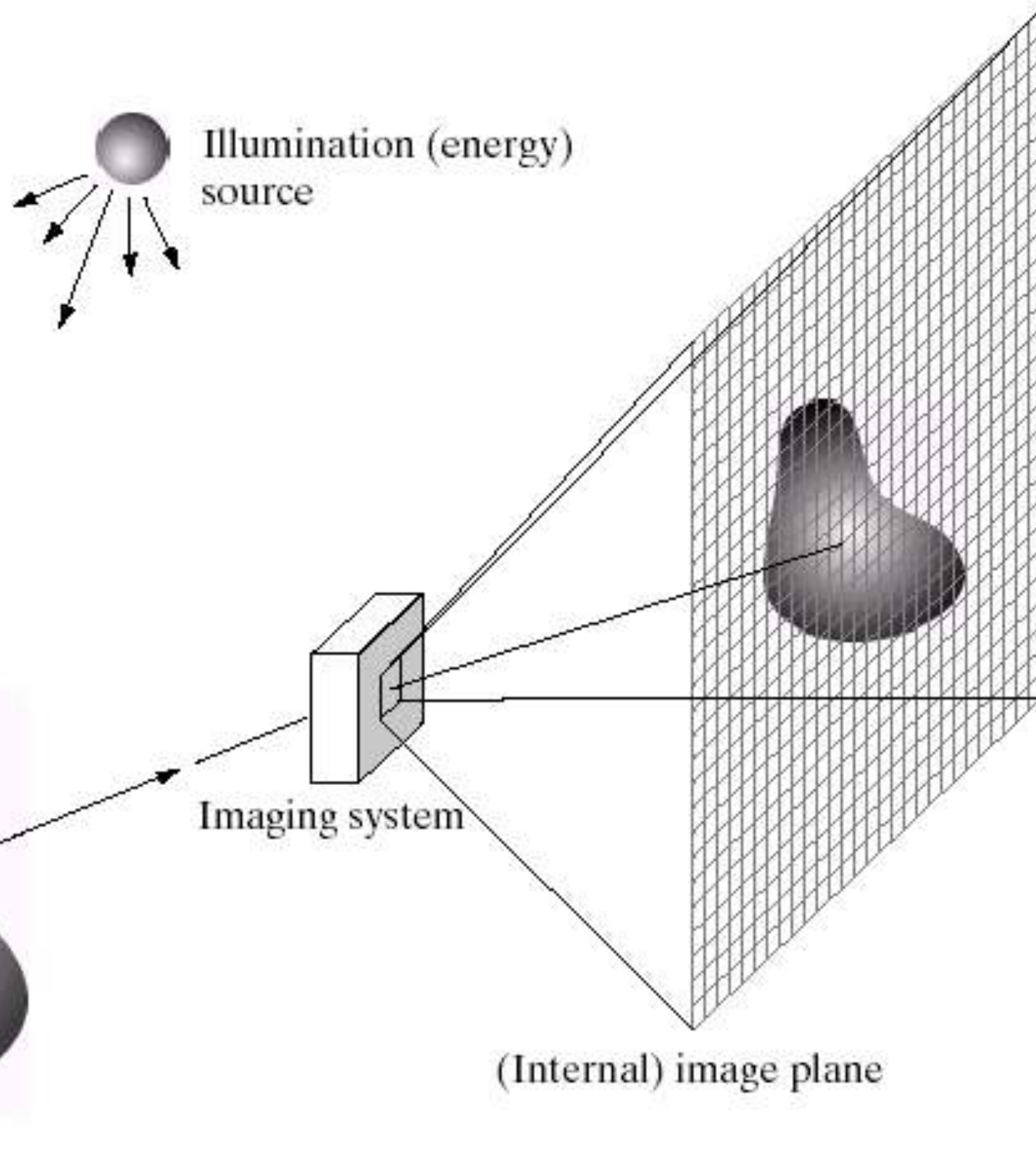




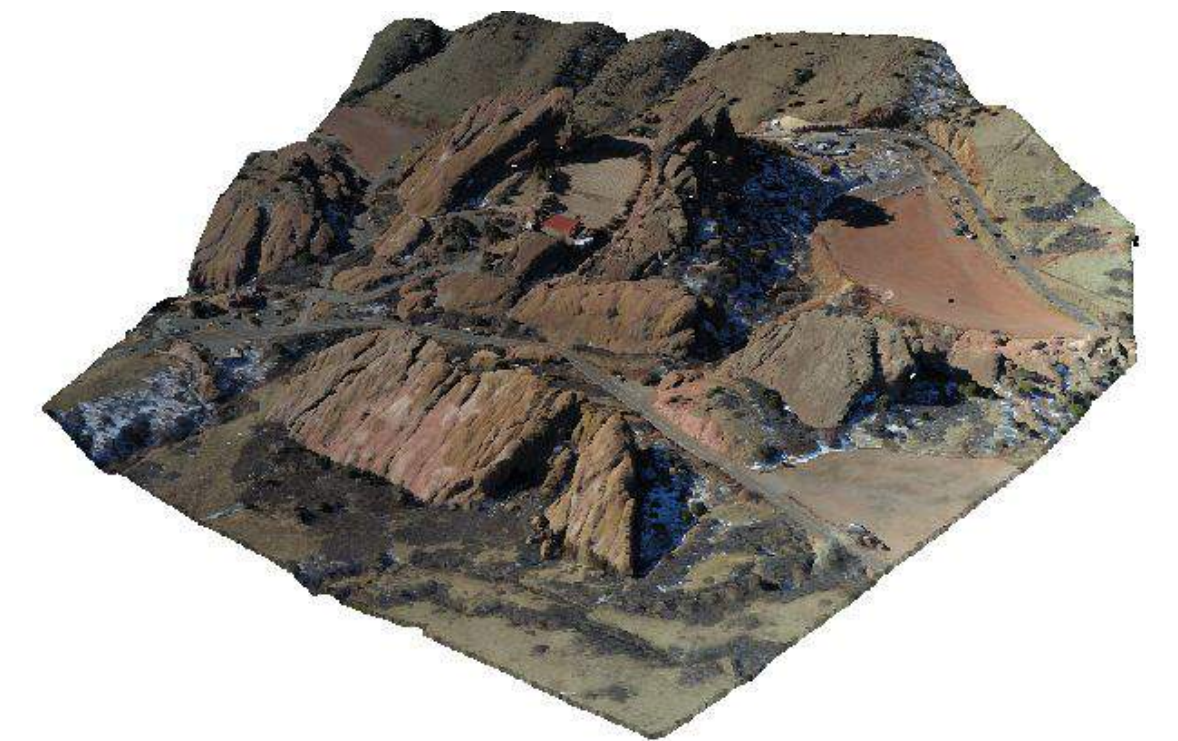
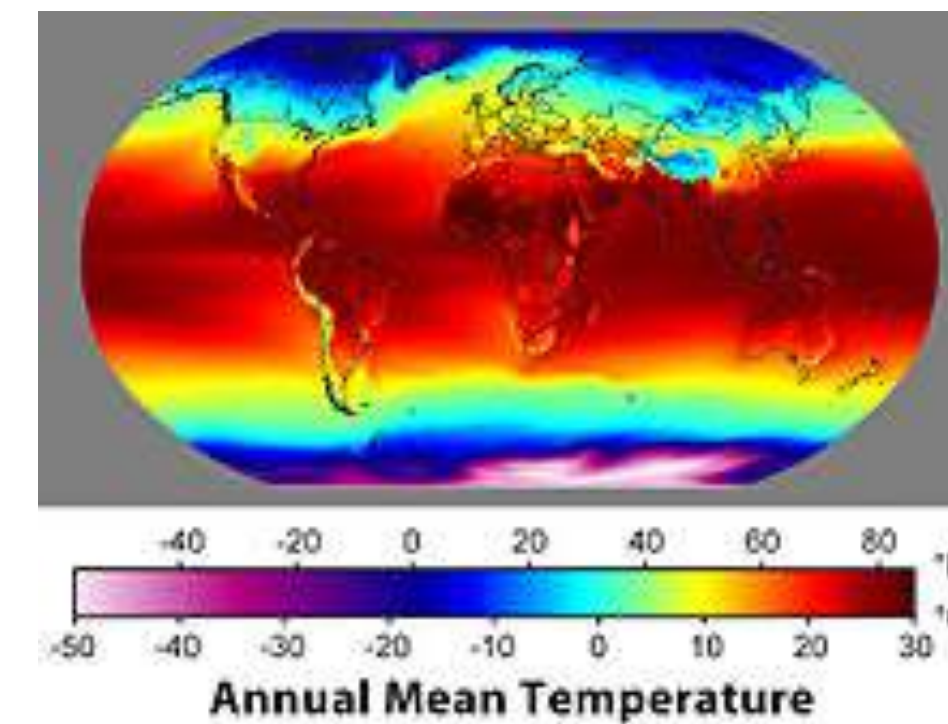
# Formulation of An Image

## As a 2D sampling of signal

**Signal:** function depending on some variable with physical meaning.



Can be other physical values too:  
temperature,  
pressure, depth ...

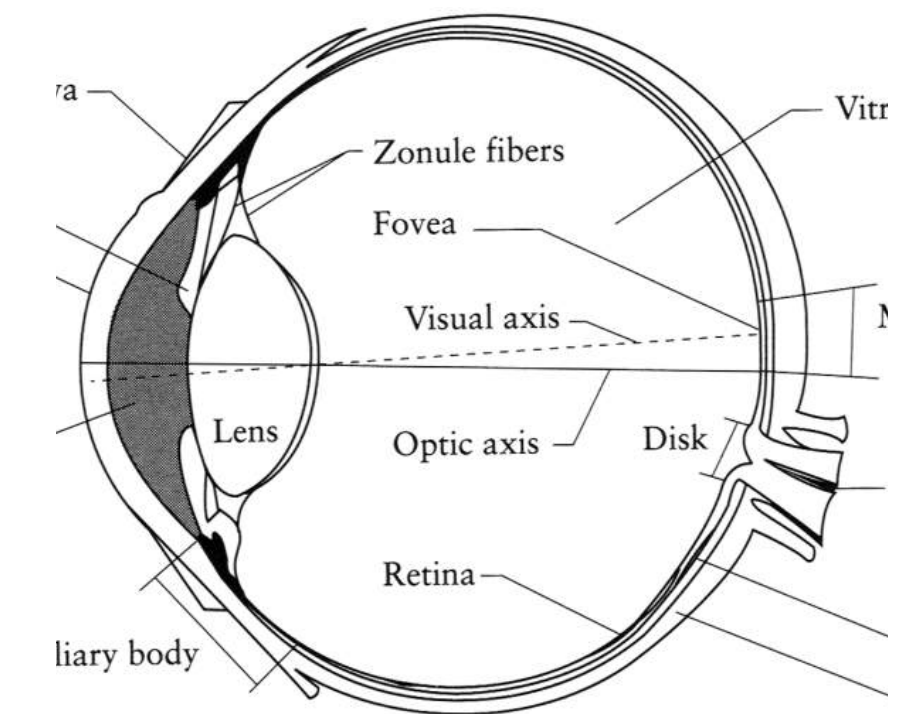
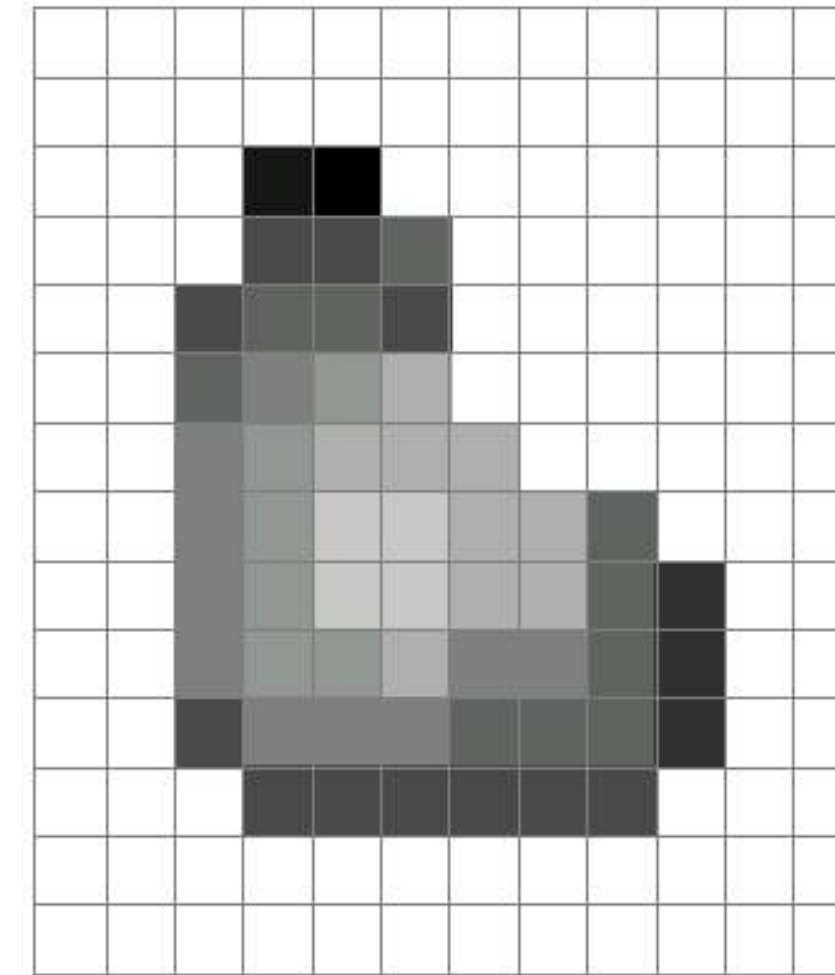
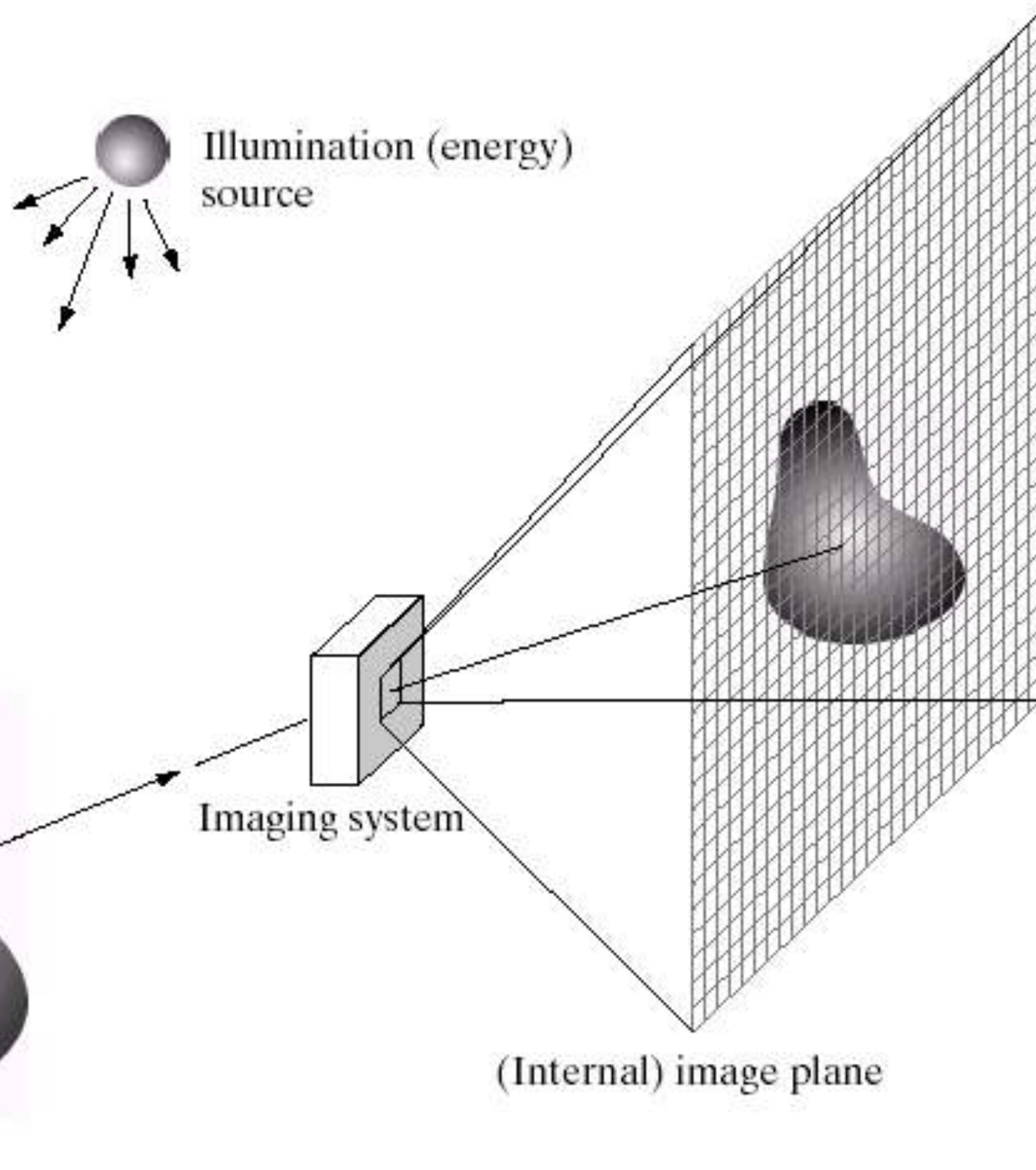




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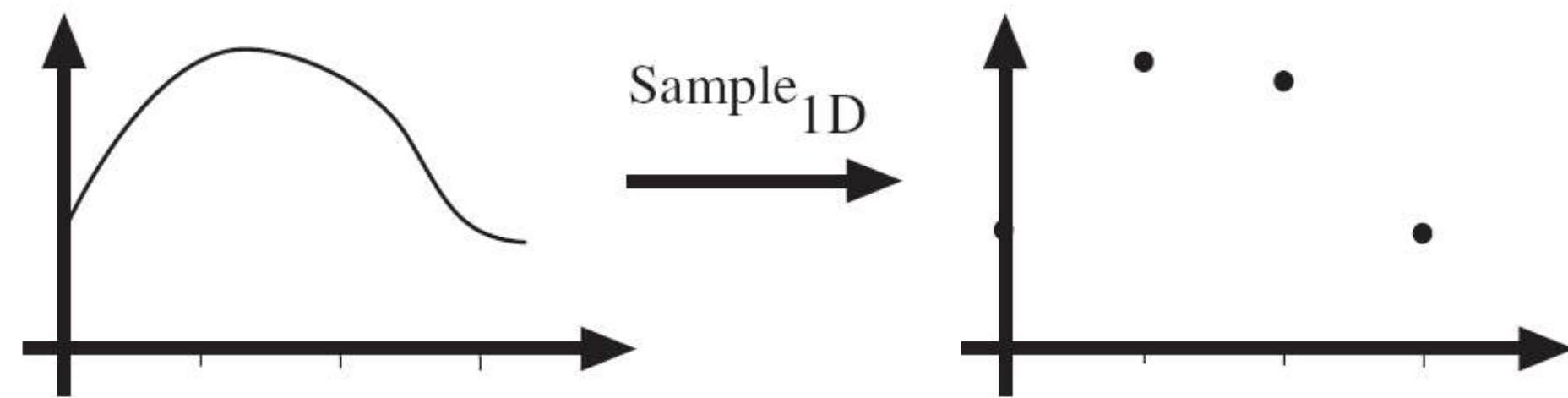


**Image:** sampling of that function.

- 2 variables:  $xy$  coordinates
- 3 variables:  $xy + \text{time}$  (video)
- 'Brightness' is the value of the function for visible light

# Sampling Physical World Using Images

## Physical Understanding of Images

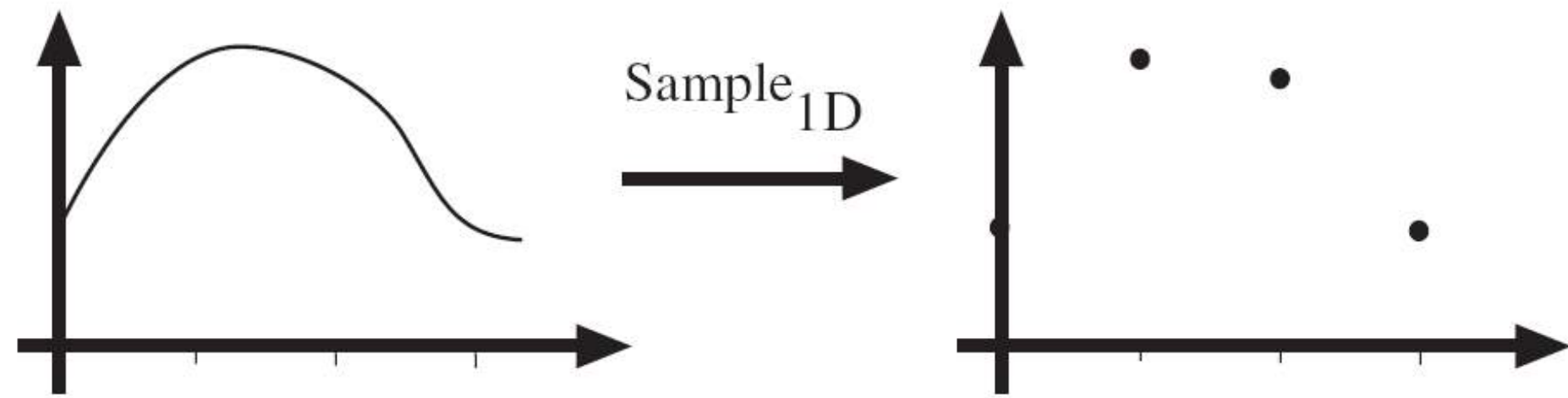


Sampling in 1D takes a function and returns a vector whose elements are values of that function at the sample points.

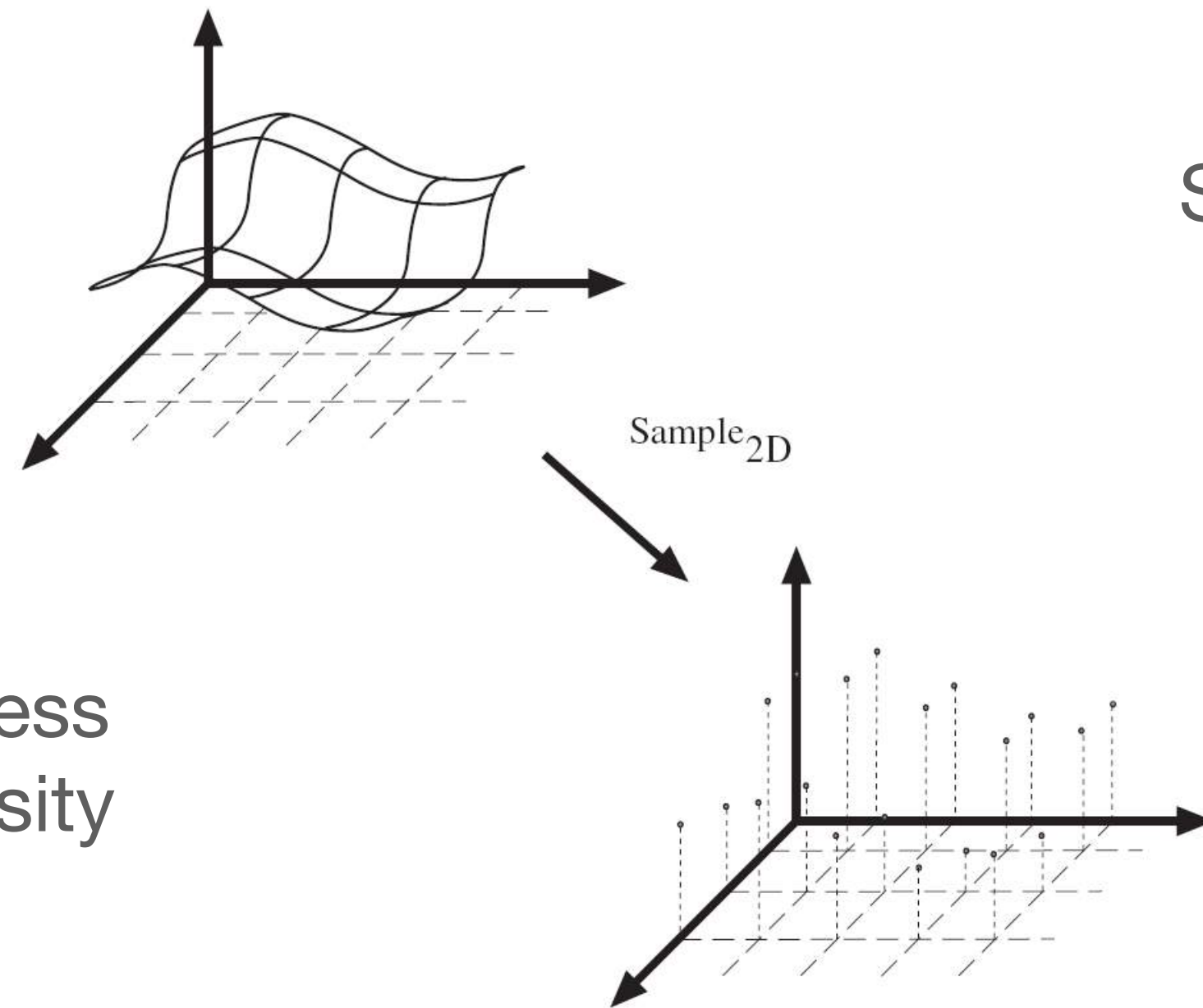


# Sampling Physical World Using Images

## Physical Understanding of Images



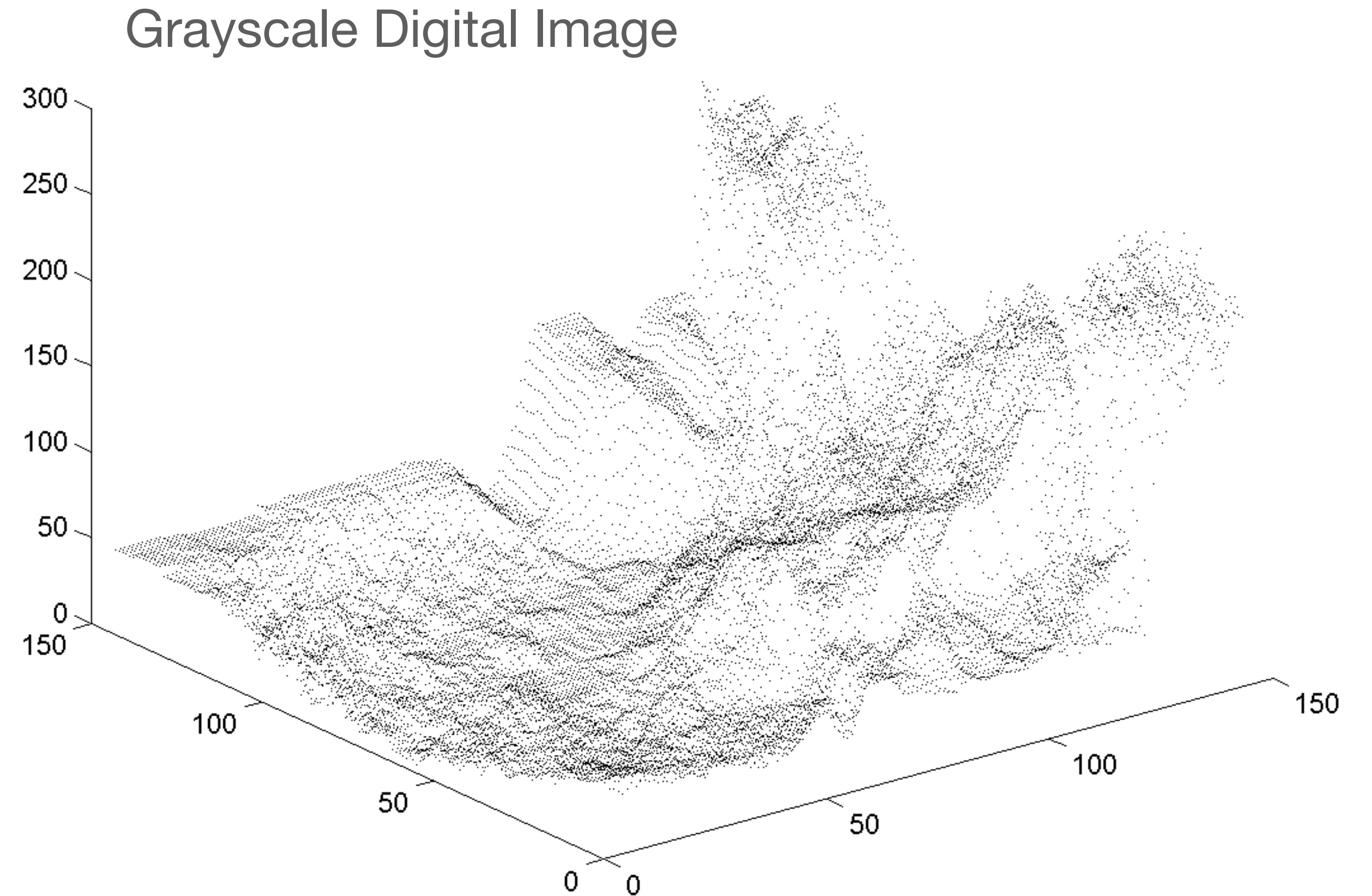
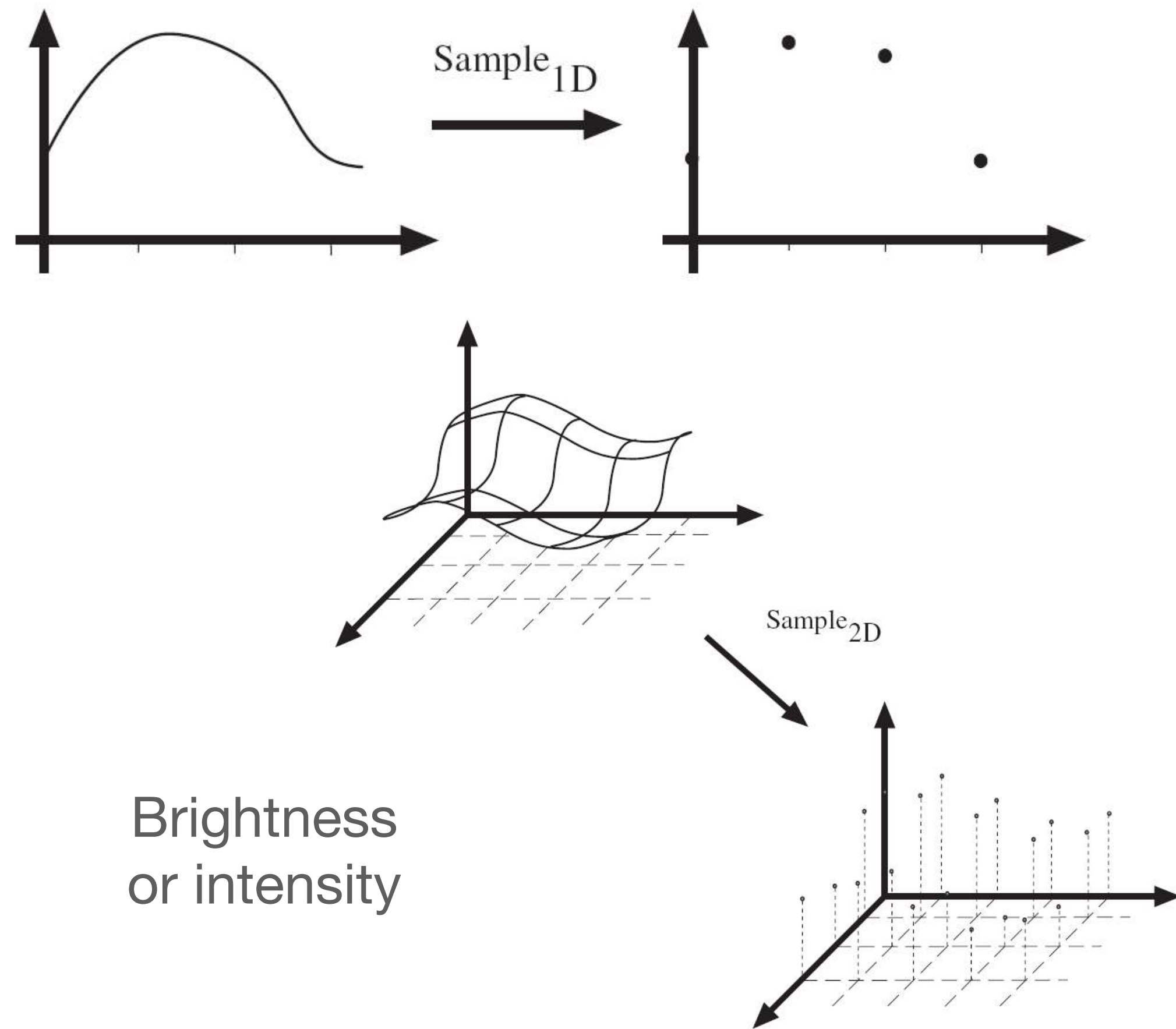
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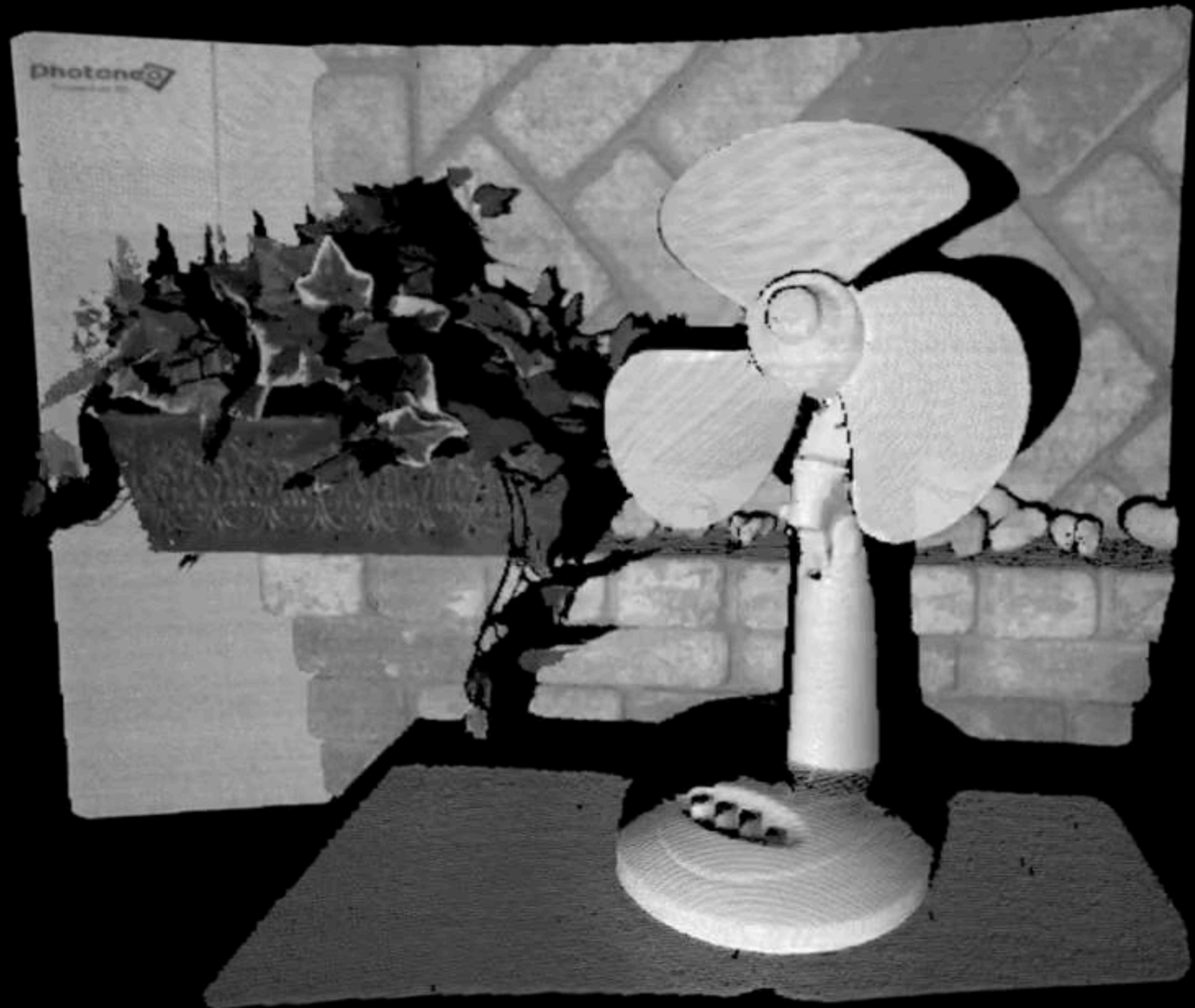
Sampling in 2D takes a function and returns a matrix.

# Sampling Physical World Using Images

## Physical Understanding of Images



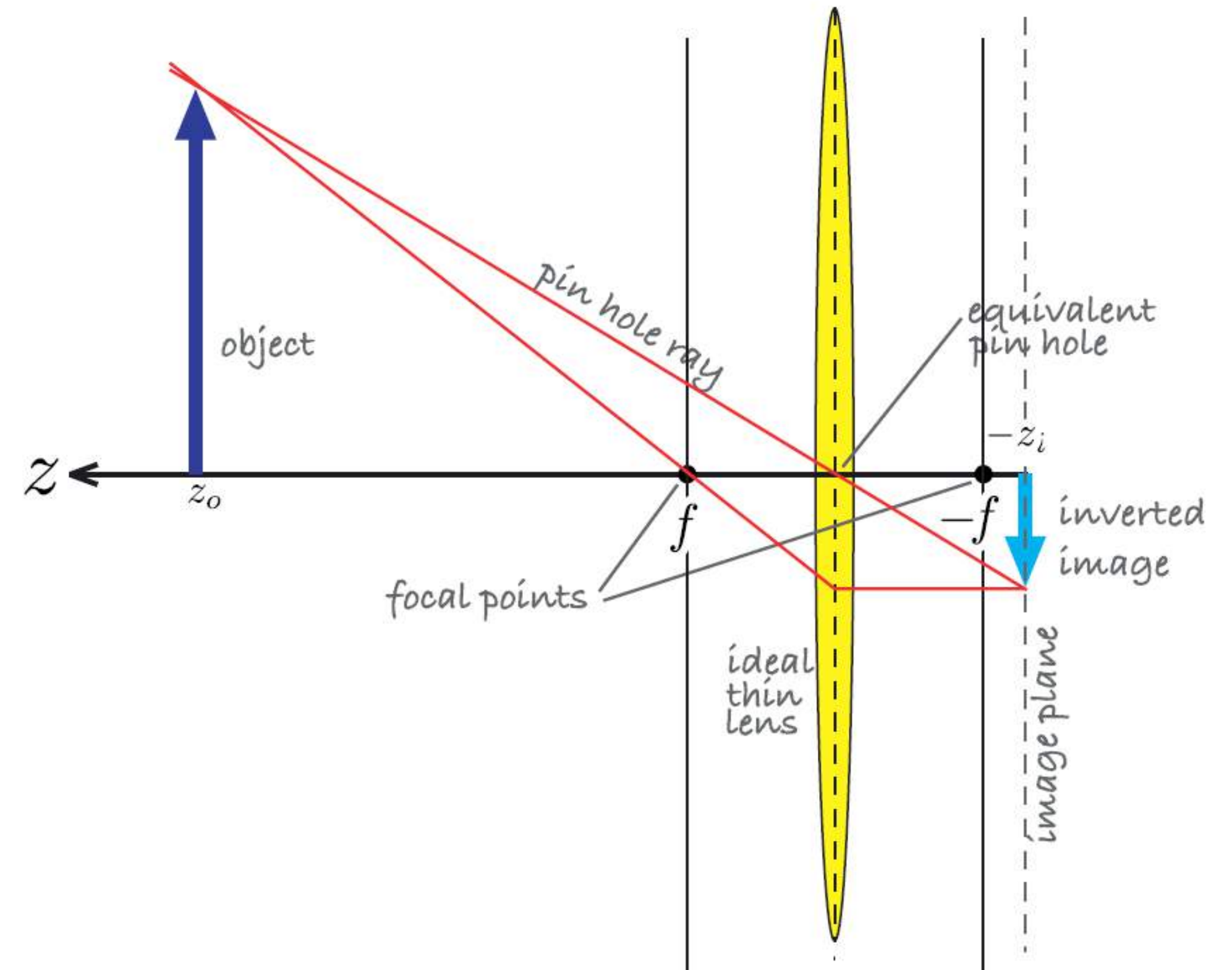
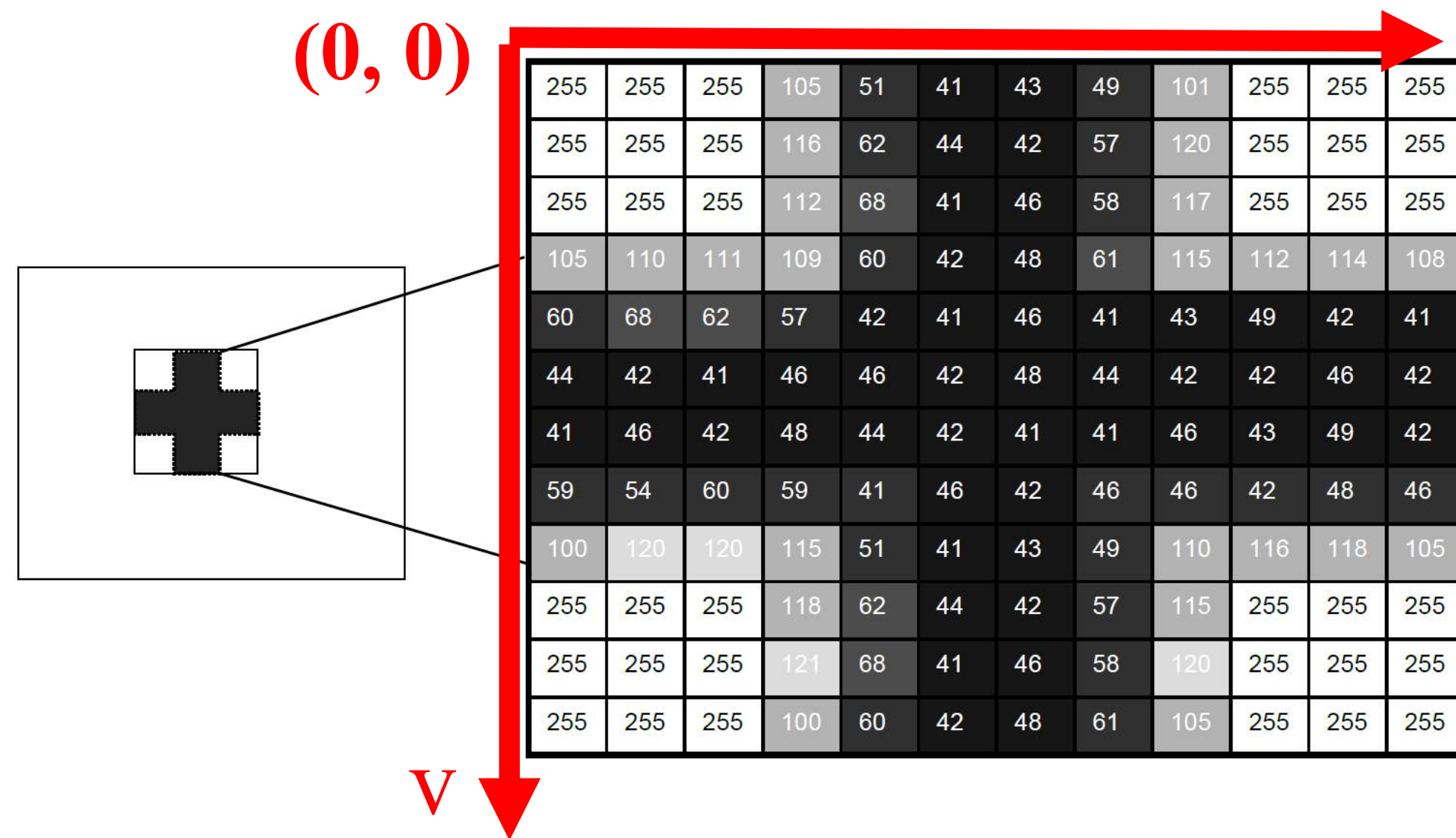




# Digital Images as Functions

## Image Coordinate System

- Example of a grayscale [0, 1] image within a planar area of size [m, n]
- Pixel as picture element

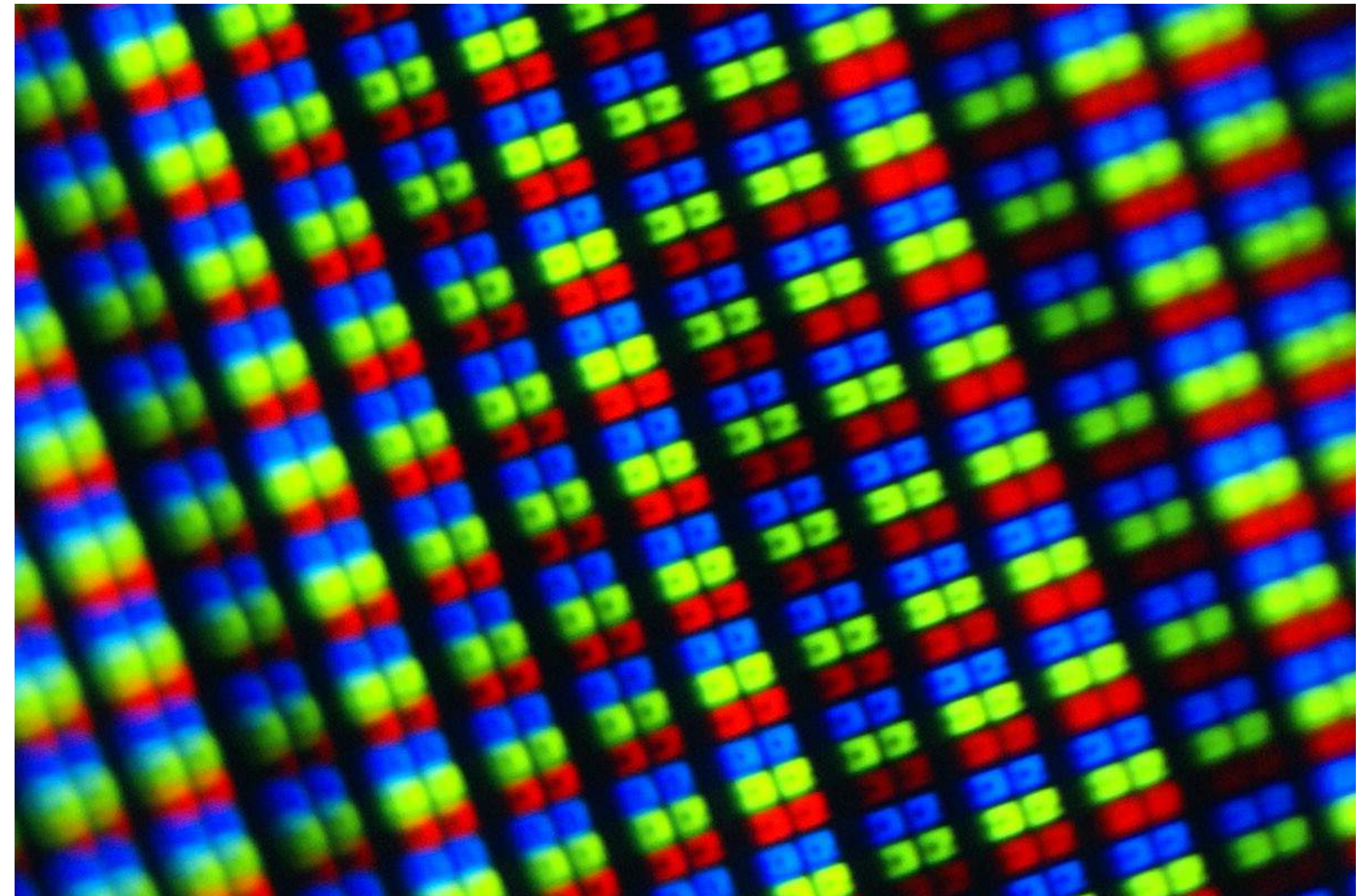
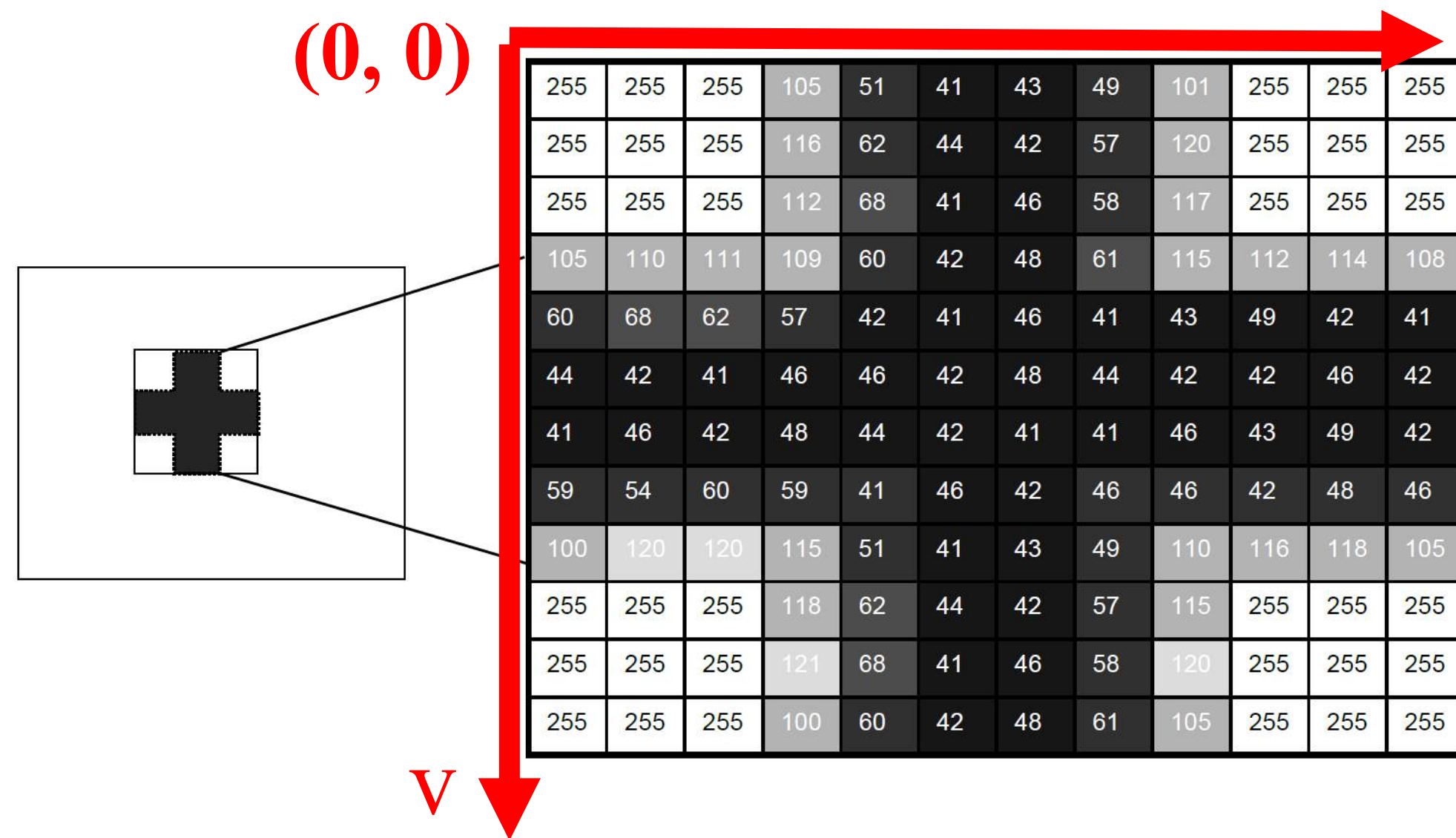




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- **NOT A SQUARE !!!**

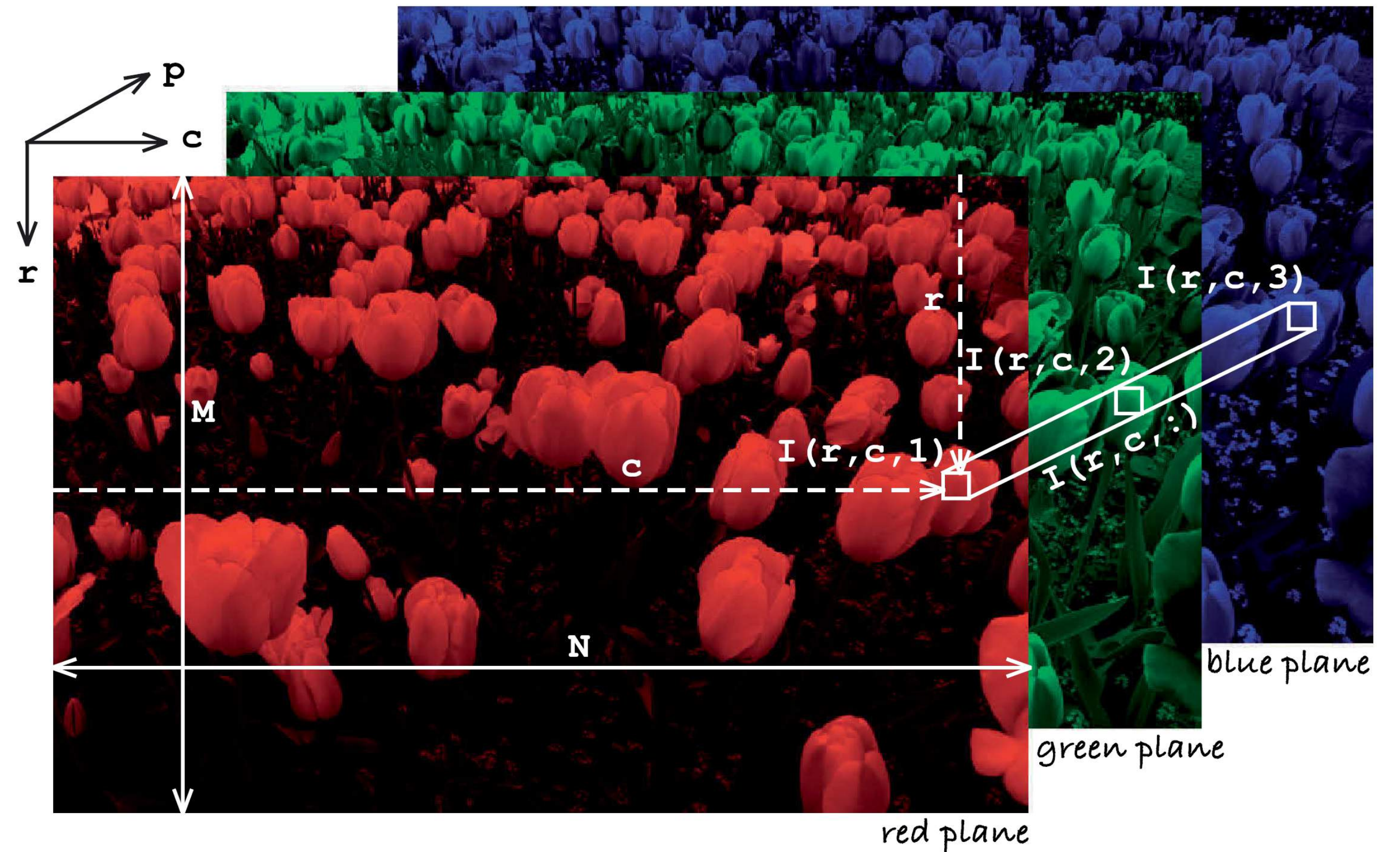
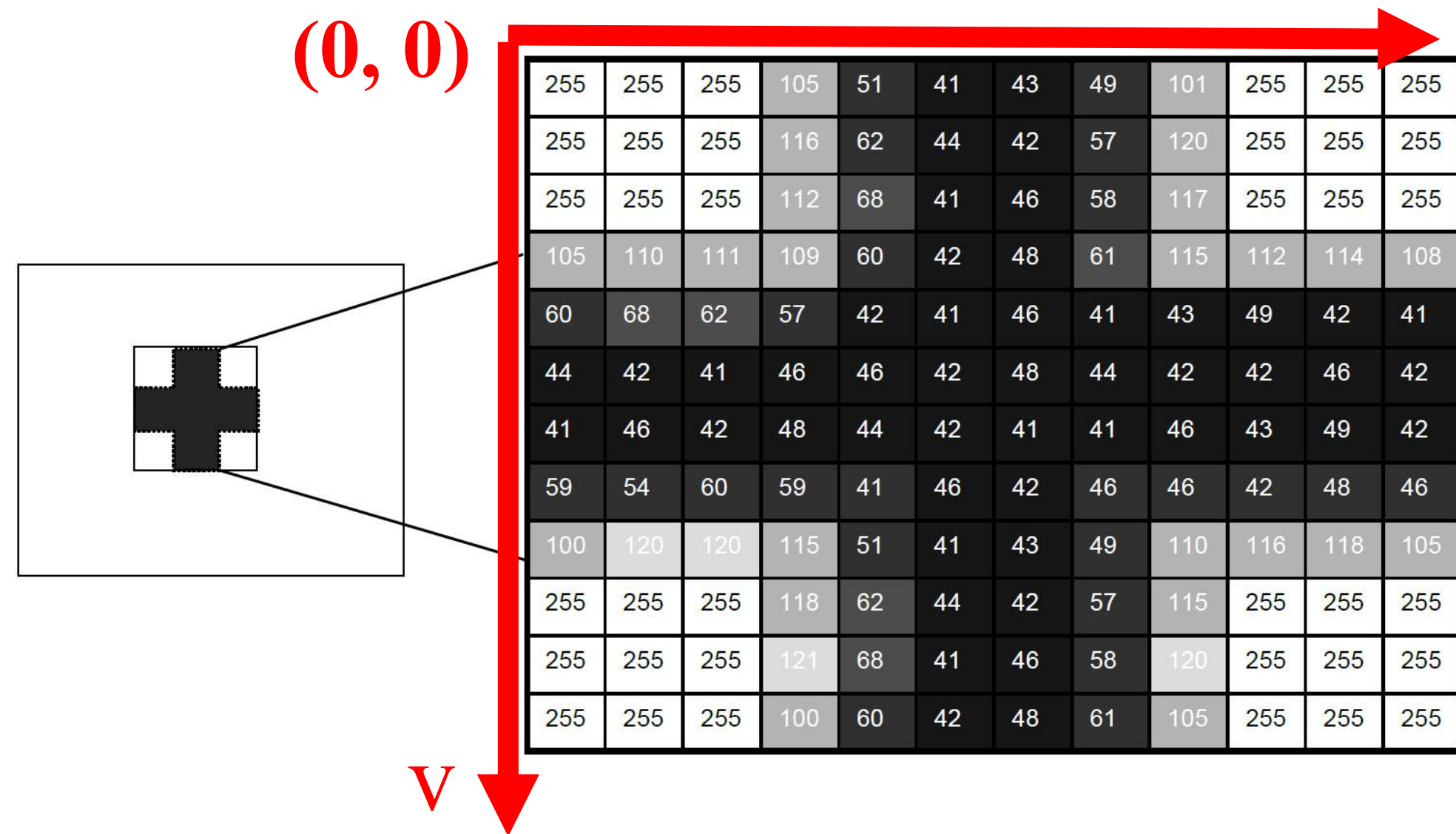




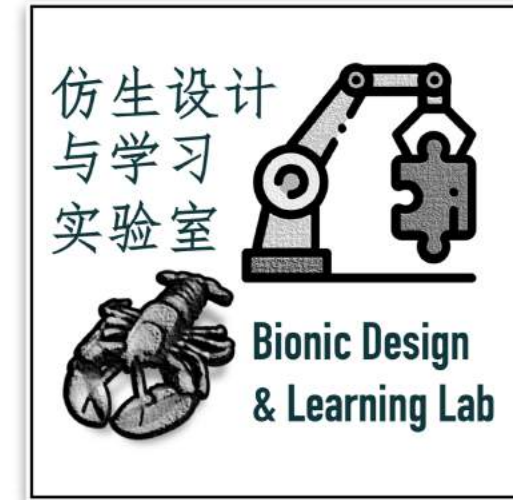
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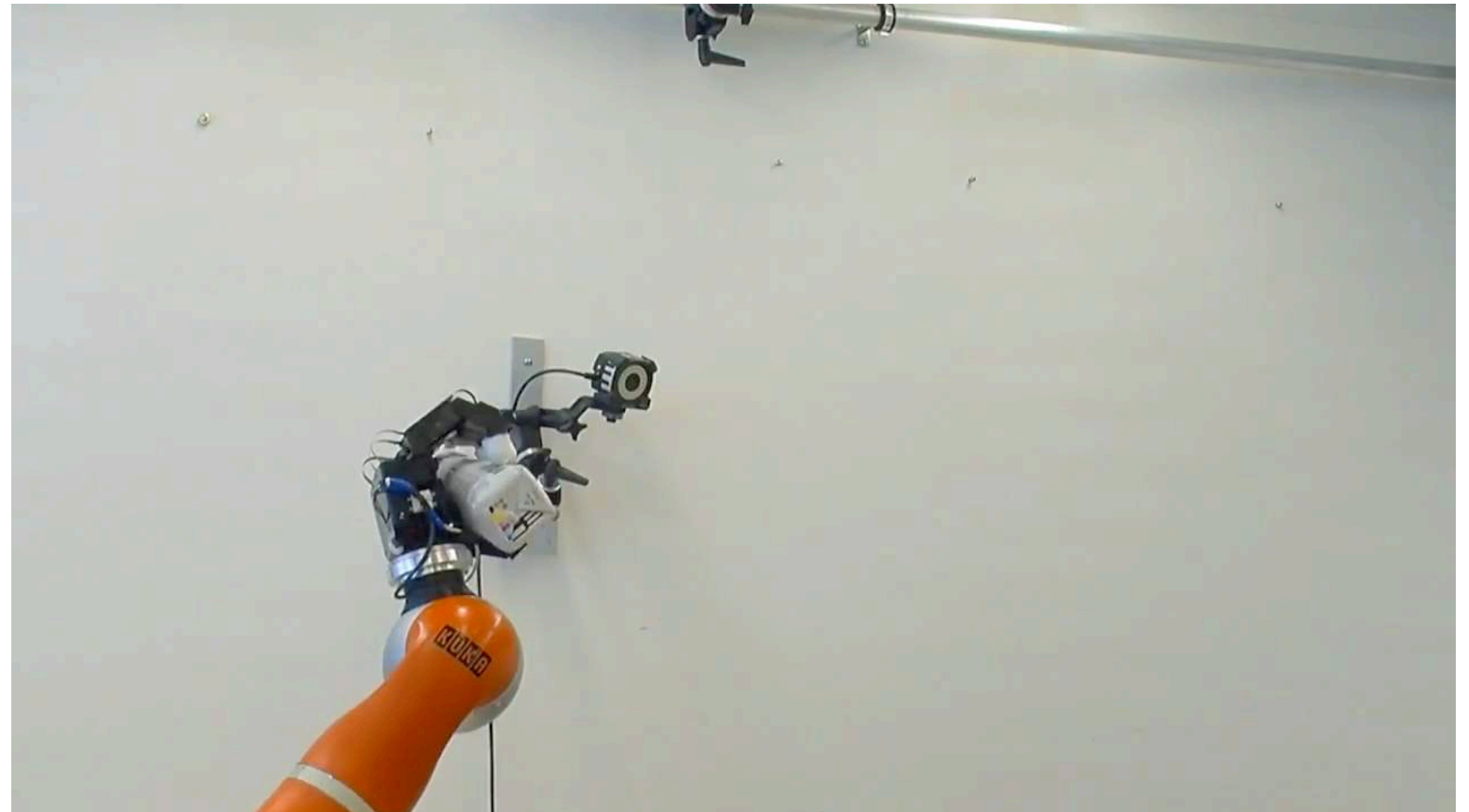
# Sense-Plan-Act

# Sense-Plan-Act

## Learn to solve the problem

To perceive its environment with visual data for action planning

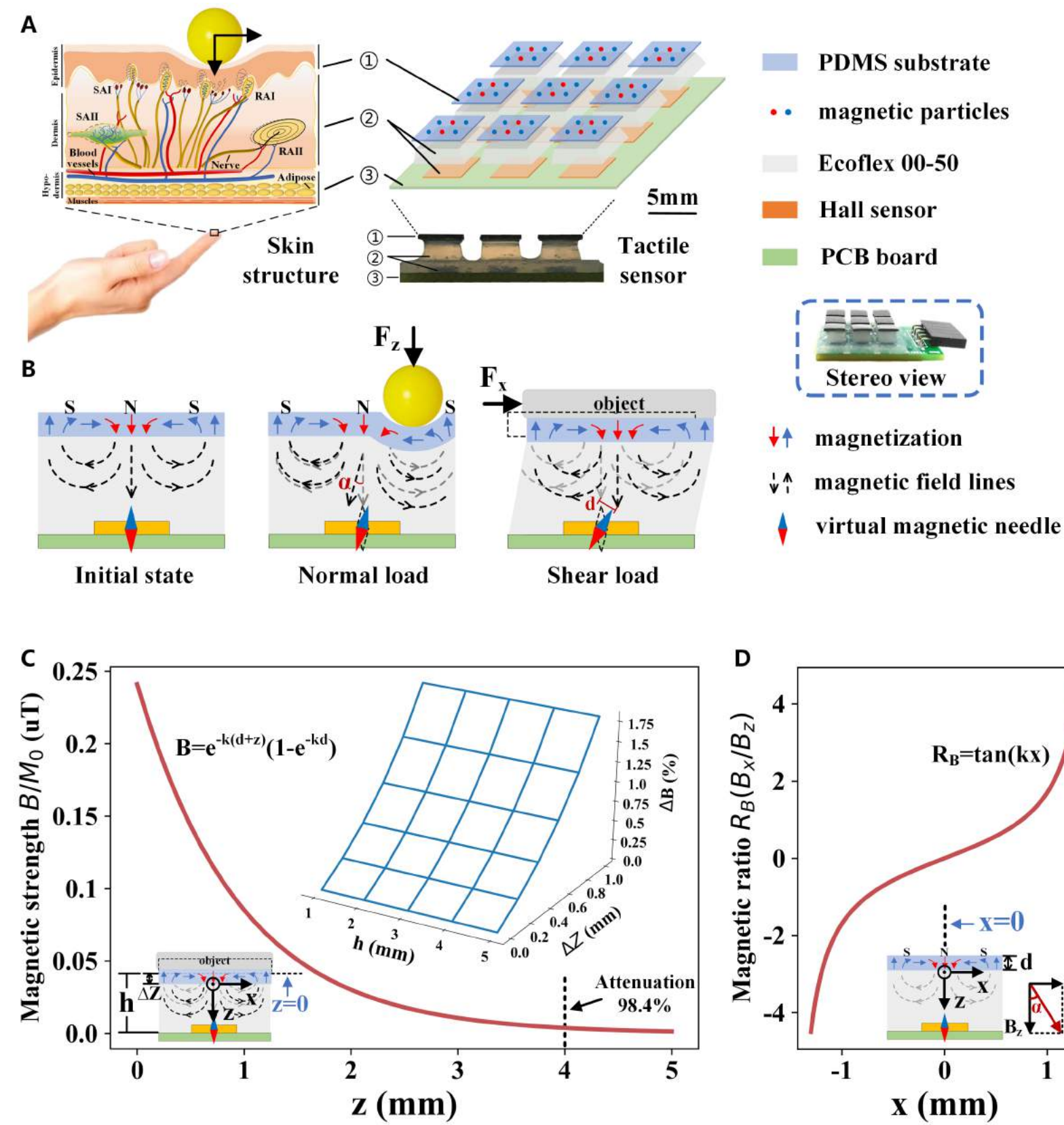
- Perception Data
  - Visual data from image sensors
  - Acoustic data from ultrasonic sensors
  - Textual data from digital documents
  - Meta data in forms of temperature, height, or others.





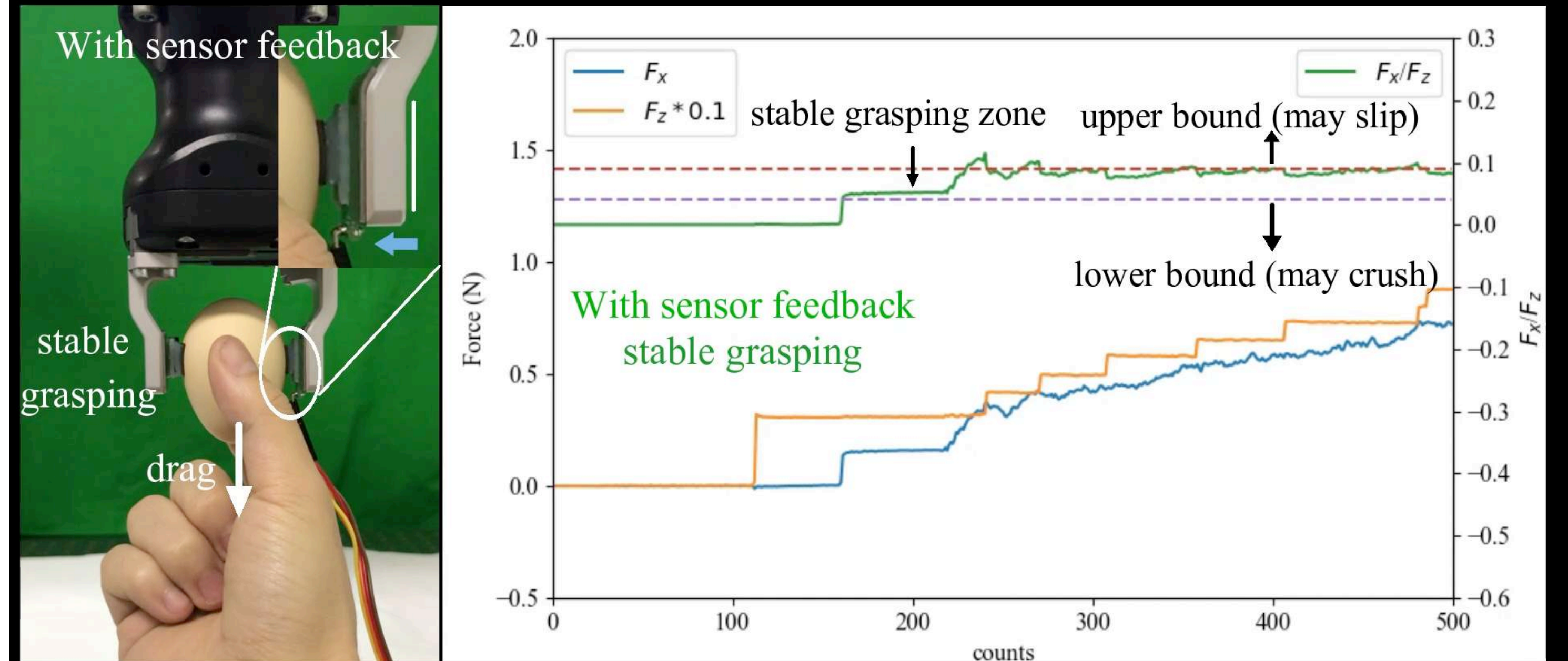
# Sense-Plan-Act

## Learn to solve the problem



### Safely Grasping an Egg with Tactile Sensor Feedback

2.5x





# Sense-Plan-Act

## Learn to solve the problem

### Waste Sorting DeepClaw using Soft Adaptive Grasping

*Integrated Vision + Touch for Enhanced Robot Learning*

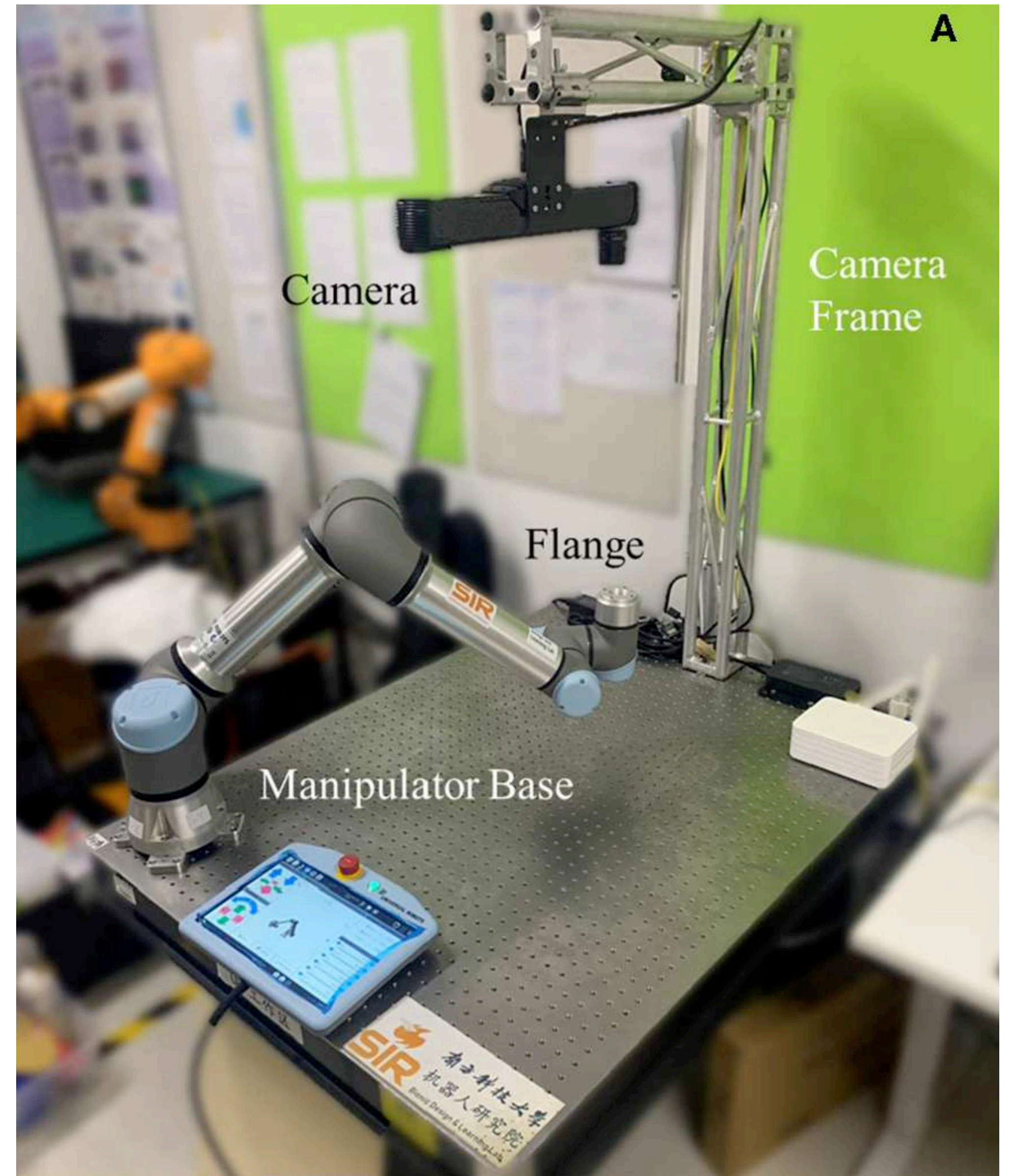


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Bionic Design & Learning Lab | Song Chaoyang | songcy@sustech.edu.cn

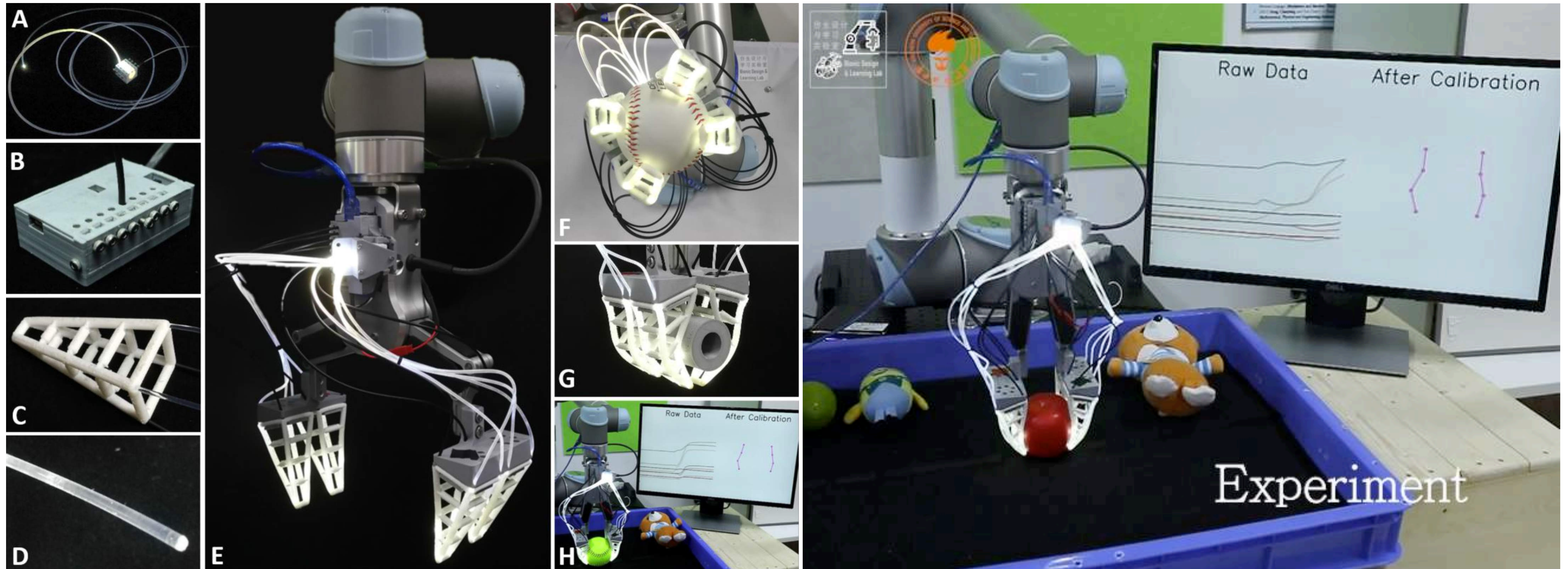
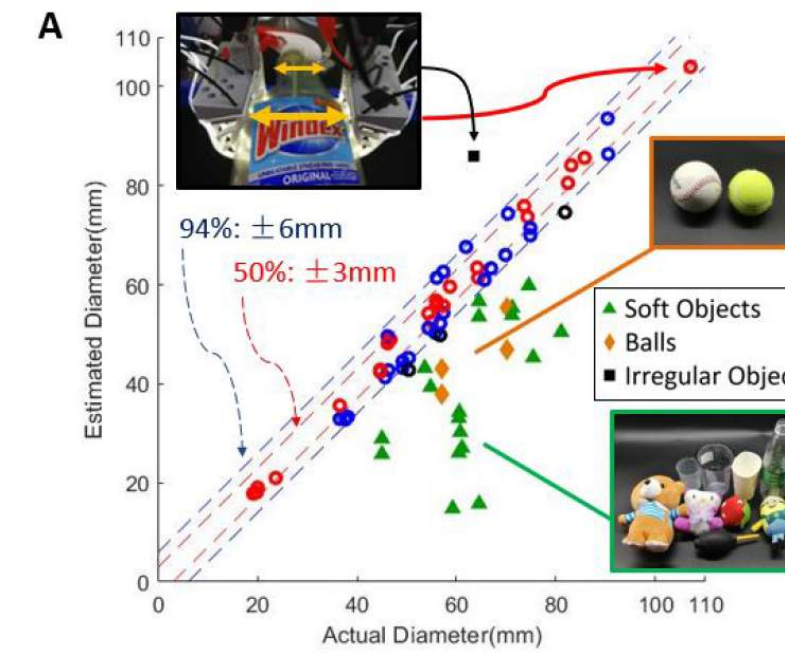
3





# Sense-Plan-Act

## Learn to solve the problem





# 在线文档的 协同编辑 原理详解

在线协同文档可以看做存储在各个客户端和服务端上的分布式数据，各个数据副本可以独立修改，最终收敛一致。本次分享将讨论协同文档设计上的两个关键问题：

- 如何实时可靠地同步协同数据？
- 如何解决协同冲突？



时间：2021年1月20日 1500-1550  
地点：新工学院大楼 北楼235号

飞书视频会议链接：  
<https://vc.feishu.cn/j/946372747>

## 何伟鹏

本硕毕业于华南理工大学软件学院，2018 至今，在字节跳动担任前端工程师，主要负责飞书文档的协同架构的设计和研发工作。



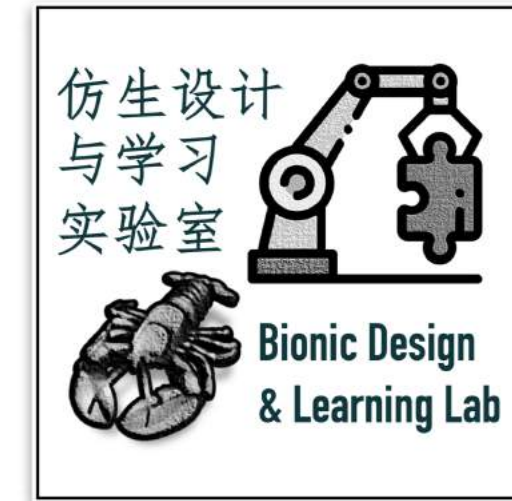
南方科技大学机器智能设计与学习教研实验室  
Machine Intelligence Design & Learning Lab

SUSTech  
Southern University of Science and Technology

ME DEPARTMENT OF  
MECHANICAL AND  
ENERGY ENGINEERING  
机械与能源工程系







# Thank you

For more information, please visit [mainDL.ancoraSIR.com](http://mainDL.ancoraSIR.com)

Song Chaoyang | Asst. Prof. | Department of Mechanical & Energy Engineering | SUSTech | [songcy@sustech.edu.cn](mailto:songcy@sustech.edu.cn)